QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

The SCIENCE COUNSELOR

Volume XIII ★ Number 1 ★ March, 1950

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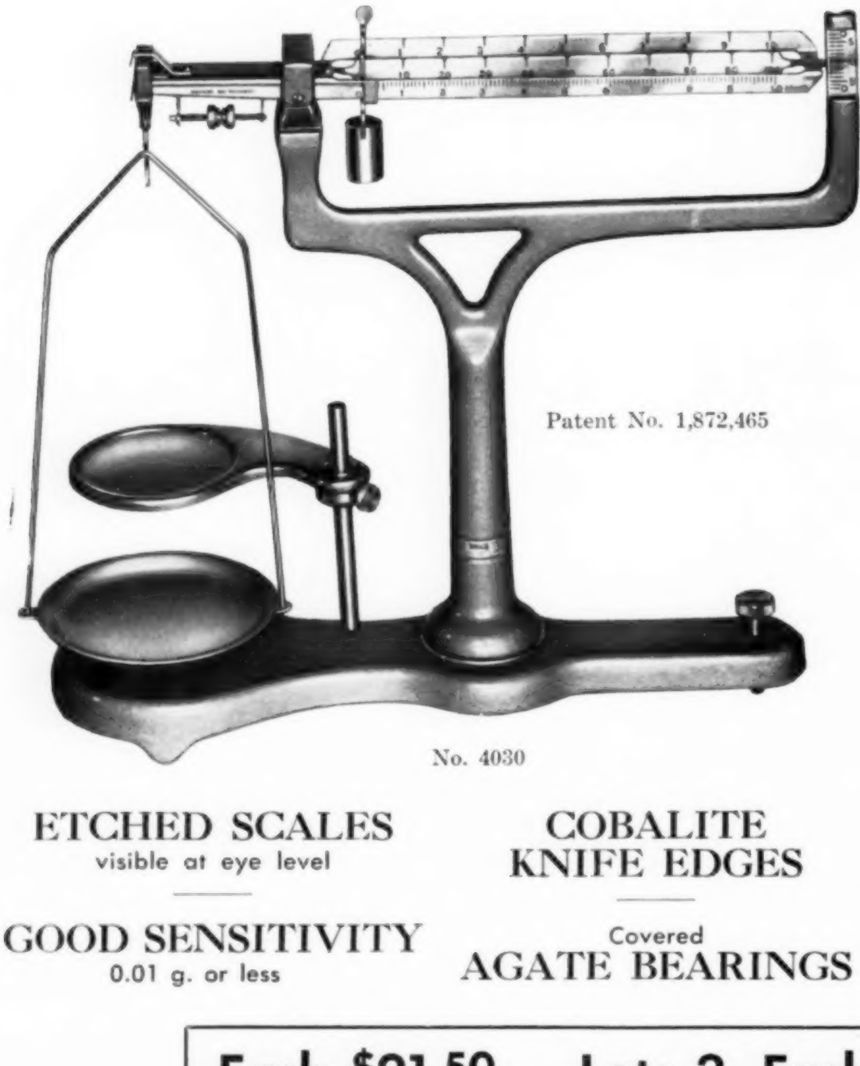

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By Lawrence Lemmon, Capital Earthworm Farm, Arlington, Virginia.

Nickel in the Modern World
By William D. Mogerman, Editor "Corrosion Reports", International Nickel Company, New York, N. Y.

Teaching Atomic Energy to Laymen
By Hew Roberts, College of Education, University of Iowa, Iowa City, Iowa.

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United States Office of Education Projects in Physics
By Bernard B. Watson, United States Office of Education, Washington, D. C.

Teaching Heredity in High School

• By W. N. Steil, Ph.D., *(University of Wisconsin)*
PROFESSOR OF BOTANY, MARQUETTE UNIVERSITY, MILWAUKEE, WISCONSIN

Long experience in education in the biological field has given the writer of this paper definite opinions concerning the teaching of high school biology. Teachers will find his views challenging.

Dr. Steil states clearly what he thinks should be taught about heredity, and outlines a number of laboratory experiments suitable for high school use.

●

There is still much difference of opinion among high school teachers in regard to the content of the biology course. However, a little thought about the matter will make it evident why there is such lack of unanimity of opinion in regard to what shall be taught.

In the first place, we are still more or less bound by the traditional courses which were often planned by the college man who thought of the high school as a miniature college. Too frequently, the college man failed to bring the work to the high school level. Some of the books, also, were written by the high school biology teacher who lacked the background and the training necessary for his undertaking. Then too, for a long time we had no clearly defined objectives when we planned the content of the course.

Often, administrative officers, including the superintendent and principal, failed to appreciate the great importance of biology in the lives of boys and girls of high school age. Consequently, the subject was quite secondary in the curriculum. In some instances even the teacher was not really engaged for teaching biology, but for other subjects, and if he was expected to teach biology, he taught the class not much of anything, since he certainly could have no well defined objectives.

It is no wonder that until quite recently much work in biology was so poorly done. Now, however, we are at the dawn of the new biology with its enriched courses, planned with clearly defined objectives, and taught by better trained teachers.

I am, however, much concerned about the future of biology and all the other sciences in our high schools. I refer to certain ideas which originate with our so-called "educationists" with their tests and measurements, and their stream-lined ideas in regard to what shall be of sufficient importance to be included in the curriculum and how it should be taught. I also refer to the fact not infrequently called to our attention, that method is considered by some to be of more importance than subject matter. Accordingly, those who have planned to teach may think they are qualified to teach if they have complied with the state "education" requirements.

I hope that no more of these education requirements will be added, and that our college and university administrative officers will not "step up" the requirements in the humanities so that when the biology major works for his Bachelor's degree, he may be enabled to pursue enough biology and closely related courses to qualify him for teaching the subject in the high school.

I think we all realize the importance of biology as a high school subject. If an education includes the acquisition of knowledge of things which are vital to the welfare, health, and enjoyment of man; the acquisition of knowledge of living things—plants, animals, and man himself and of life manifestations; and the acquisition of knowledge which enables one to meet life's problems with a true scientific attitude, I believe biology is certainly a subject which contributes much to what constitutes an education. It is a most important subject; perhaps none in the high school curriculum is more important.

I wish to remind teachers of high school biology of the opportunities afforded them in teaching their subject, since it may mean so much in the lives of the boys and girls who will be the citizens of tomorrow. In this brief discussion I shall make a few suggestions as to what we should teach of heredity to high school students.

No one doubts the importance of the subject. By the application of the principles of heredity, the quality of both plant and animal food has been improved, and the quantity increased many times. Animals and plants, to satisfy man's esthetic sense, have been produced at will. With our knowledge of heredity, man can become a factor in the betterment of the race even though the individual contribution may be somewhat small.

I shall state as clearly as possible the objectives in teaching heredity. These will serve also as a guide as to what shall be taught. At the same time I shall suggest how these objectives may be realized.

Since Mendel formulated, on the basis of scientific experiments, the laws of heredity, some attention should first be directed to his life and work. It is needless to state that generally all students are interested in the lives of the men and women who have made worthwhile contributions to our knowledge. The greater the number of associations made with the new knowledge acquired, the better the comprehension of it and the more easy its retention. Hence, the laws of heredity, to be learned by the student, should be associated with the life of Mendel. Such knowledge may also prove to arouse the student's interest in heredity and stimulate him likewise to make worthwhile contributions.

(Continued on Page 32)

Keeping Up With Chemistry

• By E. J. Crane, Sc.D., (Ohio State University)
EDITOR, CHEMICAL ABSTRACTS, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

The writer of this article is the distinguished Editor who makes completely and readily available in English to chemists everywhere the chemical literature of all the world. He supervises the 800 workers who search 4500 scientific journals printed in 31 languages, abstract pertinent articles, publish the abstracts promptly, and index them completely.

"Chemical Abstracts" will have added interest for you when you have learned how the stupendous task of publishing it regularly and on time is accomplished.

•

Imagine the predicament of the chemist eager to keep informed as to chemical advances, but confronted with the fact that these are reported in more than 4500 journals published in 31 languages. Imagine his still greater predicament, if he did not have help, when confronted with the necessity of reviewing the accumulated information on subjects in which he becomes interested in his own investigational work. It is obvious that without help both keeping up with chemistry and making state-of-the-art searches would be hopeless tasks. He does have help, the help of a staff of some 800 workers who produce *Chemical Abstracts*, a journal published by the American Chemical Society. This journal makes the accomplishment of both purposes relatively easy.

Chemical Abstracts undertakes, with reasonable promptness, to publish brief abstracts of all papers containing new information of chemical interest appearing throughout the world and also to abstract all patents of chemical interest issued in the principal industrial countries of the world. There are about 40,000 papers to be covered annually and something over 10,000 patents. About one-fifth of all patents issued are on chemical subjects and, since chemistry is a fundamental science used in just about all of the other branches of natural science, chemical papers are to be found in all kinds of scientific, technical, or trade publications.

A SECTION of *Chemical Abstracts'* office.

The 800 workers mentioned above consist of approximately 700 part-time abstractors scattered all over the world, 50 part-time section editors who help edit the abstracts in their respective fields or branches of chemistry, and 50 full-time central office workers who do the necessary editorial, indexing, and clerical work.

It is first necessary for *Chemical Abstracts* to get the needed publications for abstracting. These come from all corners of the world. Some are easy to get and some present difficult problems, particularly in wartime when keeping right up to date in scientific information is very important to a nation. The obtaining of Russian and Japanese publications has presented the greatest difficulty in recent years. Since complete coverage is important in an abstract journal the library task of *Chemical Abstracts* is a big one.

An interesting story could be told of how publications, or at least abstracts, were obtained by *Chemical Abstracts* during World War II. At one time European publications were got by having them sent through Russia and across Siberia to avoid the British blockade, and at another time a staff of seventy-five abstractors organized in Switzerland took care of the abstracting of the papers appearing in the journals of Germany and other blockaded European countries. These journals were going into Switzerland and the abstracts could be sent to us on thin paper by clipper plane. These abstracts were in German, French, and Italian so that they had to be translated upon receipt.

Once the papers for abstracting have been obtained the next step is the assigning of these for abstracting. This is accomplished on the basis of a careful record which makes it possible, with few exceptions, to get each paper into the hands of a chemist who is well informed on that particular subject or in the particular field of chemistry represented, and who reads the language in which the paper is published.

A part of the assigning, of

Mr. E. J. Crane
Editor, *Chemical Abstracts*

course, involves a decision as to whether or not a paper is of chemical or chemical engineering interest. *Chemical Abstracts* takes a generous attitude in this connection. Approximately three-fourths of the papers appearing in the journals devoted to physics are regarded as being of interest to the chemist and a fairly large percentage of papers in the biological, agricultural, and engineering journals is covered. General science journals are productive of papers suitable for reporting in *Chemical Abstracts. The Science Counselor*, for example, is systematically examined for this purpose. The trade journals devoted to specific basic industries contain many good chemical articles, reports either of experimental investigation or of experience on an industrial scale.

When the abstracts are received they must, of course, be carefully edited. They must be adequate, accurate, concise, and correct in style, form, and nomenclature, and they must be expressed in good, clear English. Much could be said about the importance of correct chemical and other nomenclature in scientific publication. The *Chemical Abstracts* office does a great deal of work on chemical nomenclature and distributes a good deal of useful information in this field.

The edited abstracts must be classified to fit into the 33 sections into which the journal is divided. This classification is on the basis of branches of chemistry and, for the industrial part, on the basis of basic industries, such as those devoted to petroleum, rubber, and plastics.

The proper length of abstracts varies considerably. Much depends on the nature of the paper or patent being covered. Abstracts average about ten to a page, the page of *Chemical Abstracts* being approximately the size of the page which you are reading, slightly smaller but printed in 8-point type (this type is a little larger than 8 point) and without space between the lines. *Chemical Abstracts* appears twice a month and it now requires something over 500 pages per month to report the approximately 5000 abstracts of the month.

The next operation is, of course, the printing of the journal. This presents some special problems because the abstracts are filled with chemical formulas, abbreviations, mathematical symbols, and the like.

The above-discussed operations carry out the principal purposes of *Chemical Abstracts*, which are (1) to be complete, (2) to be prompt, and (3) to provide abstracts of good quality. There is one other purpose which is of much importance. It has to do with indexing.

The primary general purpose of *Chemical Abstracts*, that of making the chemical literature of the world completely and readily available for use, would be defeated if it were not for the publication of extensive, carefully prepared indexes. There are so many abstracts that information contained in them, after being unearthed for ready use, would really be buried again within the abstracts if it were not for the indexes.

Some idea of the size of the indexing task is made clear by the following facts:

(1) When a number of *Chemical Abstracts* is off the press and on the Editor's desk, the task of his staff is only about half finished. The indexing remains to be done.

(2) Two-thirds as many words are needed in the production of the various kinds of indexes issued by *Chemical Abstracts* as are required for the publication of the abstracts.

(3) The 1949 annual indexes will go over 2000 pages and a ten-year index, just completed, contains 9927 pages.

When it is considered that fine print is used on these large pages so that they contain three-and-a-half times as many words as does the average textbook page it will be clear that this is extensive indexing.

Five kinds of indexes are published. These are devoted to

(1) Authors
(2) Subjects
(3) Formulas
(4) Patent numbers
(5) Organic rings

There is an author index in each number of *Chemical Abstracts*. All of the indexes are published annually and collective indexes are now published for all. Authors and subjects have been indexed collectively at ten-year intervals since the beginning of *Chemical Abstracts*, now in its 44th year, and a 26-year Formula Index is in preparation. The first thirty volumes of *Chemical Abstracts* were covered in a single Numerical Patent Index, and

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A group of Indexers dictating index entries.

Seeing is Believing

• By Ernst A. Hauser, Ph.D., *(University of Vienna)*
PROFESSOR OF COLLOID CHEMISTRY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS, AND WORCESTER POLYTECHNIC INSTITUTE, WORCESTER, MASSACHUSETTS

The writer of this excellent article is an outstanding educator who believes in the importance of visual observation in science teaching. He directs attention to some of the newer developments in microscopy and photomicrography and points out how they may be applied in the classroom. Here are new and stimulating ideas for even the most experienced teacher.

This paper is based on a lecture presented at the University of New Hampshire in August, 1949, before the Summer Conference of the New England Association of Chemistry Teachers.

•

In his Commencement Address at the Massachusetts Institute of Technology on June 10, 1949, James P. Baxter, III, President of Williams College, stressed the point that only a truly liberal education can supply a sense of values and ample sources of inspiration[1]. To this I would like to add a quotation from an article written by Samuel John Stone in 1875: "What I can't see, I never will believe in."

Having received all my schooling in Europe it is only natural that one of the first things I became interested in when I joined the faculty of the Massachusetts Institute of Technology in 1928 was acquainting myself not only with the general methods used in teaching chemistry in our colleges but also in our high schools. What amazed me most was to find how comparatively little emphasis is placed on visual observation, particularly in chemistry, but also in biology and sciences quite generally speaking. To prove that I am not the only one who takes this point of view, I would like to quote from a lecture given by a famous German scientist who had spent six months in the United States as a visiting professor a year ago:

> "The essential difference in education lies in the training method used by American universities and ours. Systematic drilling as a method of instruction as used in the United States can provide sound knowledge but it is hardly apt to promote self-reliant thinking and the spirit of research. The excessive use of the textbook, to which the student is bound in the United States, and the lack of visual experimental demonstrations works in the same direction."

If one combines these quotations, one has the answer to our educational problem. Whenever possible, we must give the student a chance actually to see the things we are talking about in classes of chemistry or lectures dealing with botany, biology, mineralogy, and other branches of natural science instead of having the student accept what he is being told or what he can read in the textbook.

Before a small class one can, of course, set up a microscope and have every student look through it at the preparation. From an educational point of view, however, such a procedure is not only tedious but of very limited value. Not only would every student have to know how to focus the instrument to suit his eye, but the teacher would be faced with the problem how to explain to every single student what he actually should see, while he is looking through the microscope. With a large class, such a procedure would be entirely impossible.

So far, the only way out of this dilemma is to throw slides of photomicrographs on the screen from a projector. Disregarding for the moment the fact that they rarely are color transparencies, which would be absolutely essential when using polarized light for the illumination of the preparation or if one wants to demonstrate the fluorescence of minerals or if one simply wants to show the preparation in its natural color, the student will never be so impressed by seeing such slides or color transparencies as if he could actually see the preparation through the microscope himself.

Quite a few of the optical firms came to this conclusion long ago, and a number of devices, for example projection prisms to be attached to the eyepiece of the microscope so that the image could be thrown on a screen, have been developed. So far, however, none of these devices has been really satisfactory, until the *Rayoscope* was developed. This instrument is certainly one of the most ingenious developments in the field of microscopic optics for educational purposes.

In principle, the Rayoscope is an inverted microscope, as shown in Figure 1. It is so built that instead of having to view the image through the eyepiece with your own eye, the microscopic picture is focused onto the white plate of the Rayoscope's stand. If one is dealing with only a small group of students, they can assemble around the instrument and the instructor can now easily draw the attention of this group to any part of the preparation he wants to. He can explain the preparation to the whole group while everyone sees it at the same time. The instrument is so constructed that it permits the introduction of polarizing disks in the path of the light, and since the stage of the instrument can be rotated it is easy to record changes in polarization. Furthermore, it enables the individual students to make accurate drawings of the microscopic image simply by attaching a piece of white paper onto the white plate.

If one has to give a demonstration to a large class, all one has to do is to set the instrument up at an appropriate place in the classroom and then tilt the top of the instrument at such an angle that an enlarged

picture can be thrown and focused on the screen in front of the class. Then the instructor can either use a pointer to explain the details on the screen, or he can stay at the microscope and obtain the same result by using a very fine needle, pointing with it to that part of the preparation he wants to draw the class's attention to. Whenever liquid preparations are involved which do not permit the tilting of the instrument, one can nevertheless throw their microscopic picture on a screen simply by placing a mirror at an angle of 45° under the objective or even under the eyepiece attachment when larger magnifications are desired (Fig. 2).

Another application of the Rayoscope which deserves special attention from an educational point of view is its applicability in photomicrography. This is always of importance whenever the instructor or a student working under him wants to have a permanent record of what he has seen.

If a darkened room is available one can obtain black and white photomicrographic negatives or color transparencies, even without the need of any camera. This is accomplished in the following way. Place four "Nuace" mounting corners, used for mounting prints in photographic albums, onto the table of the Rayoscope and space them so that they will take up the film one wants to use. After the instrument has been focused, the lights in the room are turned off, except of course for such safety lights as are permissible for the type of film used, and the film is then inserted in the Nuace corners with its emulsion side upward, and the exposure is made. The time of exposure will of course vary with the speed of the film used, but a few test exposures will very soon give the correct exposure time. The exposed film is then placed in a black paper envelope and can then be processed in the regular manner. If one is not interested in making a black and white negative or a color transparency which would permit the making of as many prints therefrom as one wants later, one can substitute for the negative film or color transparency film a so-called positive paper or an Ansco color positive in the same way and obtain one black and white or one color print immediately after developing them.

Teachers who have neither a Rayoscope nor a darkroom at their disposal and are also not in possession of photomicrographic equipment, but still would like to demonstrate quickly to their class what you can see in a microscope without every student having to adjust the instrument for his eye, may take advantage of another quite recent development in photography which has offered the solution to this admittedly perplexing problem. The answer to it is the Land-Polaroid camera[5]. All one has to do is to build oneself a stand for the camera which permits it to be swung over the eyepiece of the microscope, as shown in Fig. 3[4]. When the instructor has placed the preparation in focus all he needs to do is to swing the camera, with its lens set at infinity, over the eyepiece of the microscope and make the exposure. One minute thereafter the finished print can be removed from the camera. It can now be handed to the class, or if the instructor has at his disposal a projector equipped for projecting nontransparent sheets of paper, he can

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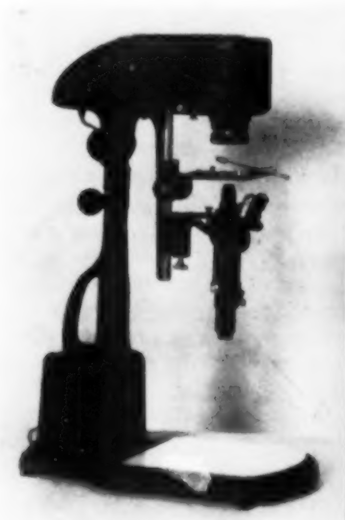


FIGURE 1. Rayoscope set for projection directly onto table.

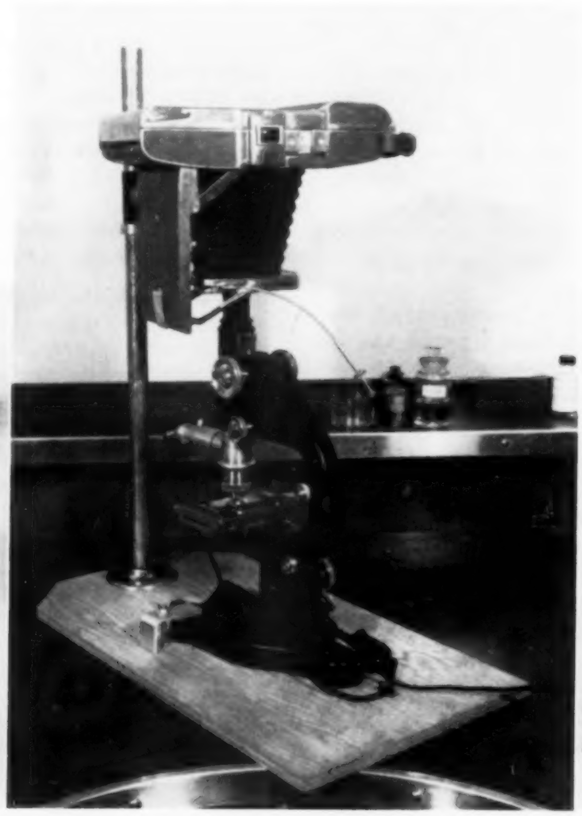


FIGURE 3. Ultropak microscope with Land-Polaroid camera ready to take photomicrograph.

FIGURE 2. Rayoscope with reflecting mirror used when studying liquid preparations which should be projected onto a screen.

Plant Growth Hormones

• **By A. J. Haagen-Smit, Ph.D.,** *(Rijks University, Utrecht)*
PROFESSOR OF BIO-ORGANIC CHEMISTRY, CALIFORNIA INSTITUTE OF TECHNOLOGY, PASADENA, CALIFORNIA

This brief but stimulating paper describes some of the work done in developing our present day knowledge of the phytohormones that govern plant growth phenomena. It shows how some of these interesting substances were detected, isolated, and identified, and how they affect the development of the plant.

Teachers of biology especially will appreciate Dr. Haagen-Smit's helpfulness in describing a number of plant hormone experiments that can readily be performed in the class room or garden.

●

At the beginning of this century it was well established that in addition to carbohydrates, proteins and fats, small amounts of other substances are necessary for the maintenance of normal metabolism in the animal organism. If these specific compounds, called vitamins, are absent from the diet, deficiency conditions develop such as beriberi and scurvy which are due to a lack of vitamins B_1 and C, respectively. While the vitamins are supplied by a source outside the organism, preferably the normal diet, there are other specific substances which are produced by the organism itself and which are just as important for the general well-being. These substances are produced in glands in the body, and the blood stream carries them to places where they are required. Their action in steering a number of physiological reactions led to the introduction of the name *hormones*, derived from the Greek *hormao*, meaning "to stir up or excite." Deficiencies in the synthesis of these hormones result in well known diseases such as diabetes, which occurs when the pancreas gland fails in its production of insulin.

Plants also produce specific substances governing numerous processes. Growth phenomena furnish the most striking examples of plant hormone action. Although there might be enough nutrient materials at the region where growth could take place or where new organs such as roots could be developed, the presence of specific substances is necessary to start the mechanism required for growth. These substances are active in very small amounts, and are produced in special regions of the plant and transported to another part to evoke some reaction. Their action is in principle very similar to that of the animal hormones, and they have therefore been named *phytohormones*.

Growth in animals takes place by cell division and subsequent growth through an increase in organic material. In plants, this phase is followed by a large increase in size, a cell elongation, through the uptake of water. This type of growth has been studied especially on the coleoptile of etiolated oat seedlings. When oat seeds are germinating we see in the course of one day the rapid growth of the root and of a structure which has been called the coleoptile. In the dark this coleoptile grows to a length of 5-6 cm. in 3-4 days, after which the primary leaf breaks through. In mature grasses we can often find the coleoptile shriveled up at the base of the stem.

It has been shown that the coleoptile grows towards the light and bends upwards when held horizontally. Both these phenomena, phototropism and geotropism, were shown to be due to redistribution of a substance produced in the tip of the coleoptile. If we cut off the tip, growth comes to a halt and the reactions to light and gravity are also prevented. If the tip is replaced on the coleoptile stump, the plant reacts again as a normal coleoptile. That a substance is actually produced in the tip can be shown by placing it on a small piece of gelatin or agar. The substance formed diffuses into the agar, and if after several hours the agar is placed on a coleoptile stump, renewed growth will take place and geo- and phototropic responses can also be shown.

A quantitative assay was based on this experiment by placing the agar block containing the growth substance on one side of the coleoptile. The resulting growth on only one side of the coleoptile will cause a bending away from the agar block, and this bending is directly proportional to the amount of growth substance present. (see Fig. 1). This experiment has been of fundamental significance for the development of the plant hormone field. With the help of a test method the relative amounts of growth substances could be detected in extracts and purification attempts could be started. Many materials such as culture media of fungi and bacteria will give curvatures on the Avena test. When it was shown that urine contained substances that caused the coleoptile to bend, it was used as a starting material for isolation of growth substance. The crystalline, pure growth hormone which was obtained after many purification steps proved to be a

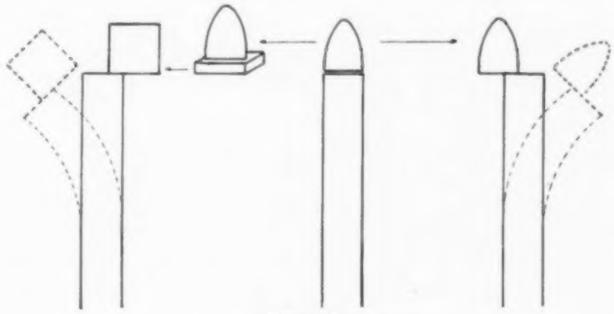
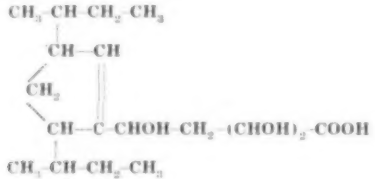


Figure 1.

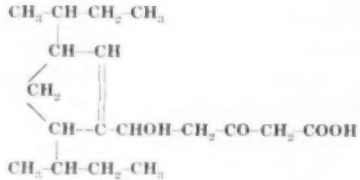
DIAGRAM SHOWING bending of avena coleoptiles with application of severed tip or of agar block into which the growth substance has diffused. (Primary leaf omitted for clarity.)

nitrogen-free substance containing carbon, hydrogen and oxygen in the following proportion: $C_{15}H_{32}O_5$. In addition, a nitrogen-containing compound identical with β-indole-acetic acid was isolated, which was active as growth hormone. These same substances were later isolated from plant material, and in addition a third hormone, auxin b, was obtained. Their chemical structures are indicated in formulae I, II, and III.



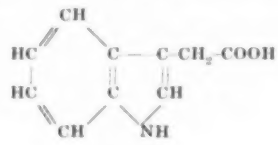
Auxin a

I



Auxin b

II



3-Indoleacetic acid

III

Indoleacetic acid is readily available by synthetic methods, and has been used extensively for investigation of the effect on plants other than the oat seedling. It was shown that the same substance induces root formation, prevents fruit drop and dropping of leaves, causes development of fruit without seeds, inhibits the outgrowth of buds, and in the case of pineapple, induces flowering. Modification in the chemical structure of the natural hormones led to the finding of the weed killing action of substances such as 2,4-D (2,4-dichlorophenoxy-acetic acid).

While most of these experiments must be carried out under controlled conditions in greenhouses or darkrooms, those who want to demonstrate the effects of plant hormones in the classroom or in their own gardens can do so quite easily and inexpensively. Some of the growth hormones are available in garden supply stores both in crystalline form or in solutions, and can be used not only for rooting of cuttings, but to demonstrate the swelling of the stems, the curvatures of the stems, etc.

The application to intact plants can be made with advantage by using a paste made by dispersing 0.01 - 1.0% of one of the hormones such as indole butyric acid or naphthaleneacetic acid in lanolin. When the lanolin is applied to the side of a stem, for example, in tomato or tobacco plants, an abundance of roots will appear near the treated area. If the plant is placed under a bell jar to maintain a humid atmosphere, the young roots will be able to continue growth, and after a few weeks will form a thick mantle covering the lower stem. It will also be noted that the angle formed by the leaf stems and the main stem will be changed (the epinastic response).

A good object for demonstrating the hormone effect is found in Tradescantia, (Spiderwort). When sections of the stem containing a few leaves are placed in water, they usually root well. When, however, the leaves, which produce the growth hormone, are cut off, and only internodes are used, root formation does not take place. Placing the leafless internodes in water containing the above mentioned hormones, or application of the lanolin hormone paste to the top of the cut stem will result in numerous roots at the base of the stem.

Many other plants such as chrysanthemum, privet and lantana lend themselves to demonstration of hormone activity. In general, a few milligrams of hormone per one hundred milliliters of water is sufficient to incite rooting when the cuttings are exposed to the solution for several days. The hormone action consists in the initiation of root growth, but it simultaneously inhibits the growth of roots already formed. It is therefore necessary to replace the hormone solution with fresh water once the roots have formed.

An experiment which will show the effect of the hormones in one day can be carried out in the so-called "pea test". When peas are planted and grown in the dark for about one week, the terminal buds are cut off, and the upper four to five centimeters of the remaining stem are used for the experiment. This piece is split lengthwise with a razor blade into two equal halves for a distance of about three centimeters from the top. The split stems are then placed in a dish containing some solution of growth hormone. The next morning the split halves of the stem will have curved outwards in a control solution of tap water, whereas those in a test solution will have a strong inward curvature due to increased growth of the outside part of the stem. (see Fig. 2). The inward curvature is a measure of the strength of the solution, and when equal concentrations of growth substances are used, it is a measure of the potency of the compound. Weed-killers such as 2,4-D will give a similar effect.

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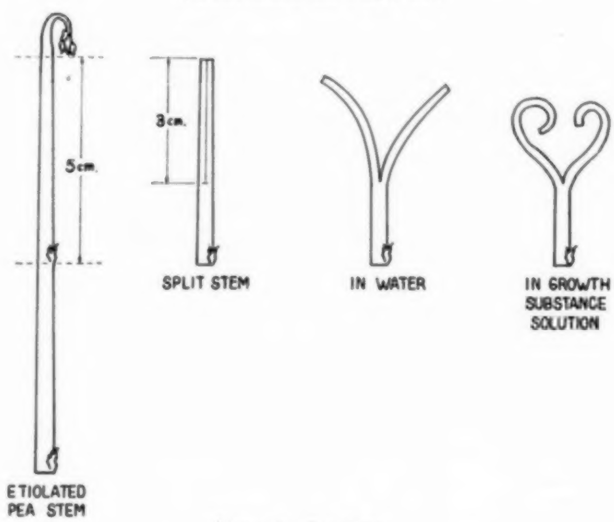

Figure 2. Pea Test.

RADIOISOTOPES---Scientific Research Tools

● **By Nathan H. Woodruff, Ph.D.,** *(George Peabody College)*, **and**
E. Eugene Fowler, M.S., *(West Virginia University)*
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Biologists, chemists, physicists, engineers, physicians and other scientific workers are making increasing use of radioisotopes in their investigative researches, since tagged atoms can be used to trace materials through physical, chemical and biological systems. Once produced only in minute quantities at great expense, they are now readily available to qualified workers everywhere.

This article relates how tracer atoms are used in studying the mechanism of photosynthesis, the utilization of fertilizers, and the obtaining of physical data. Industrial and medicinal uses receive consideration.

●

Introduction

Just a few years ago radioisotopes were the tools and the special province of the physicist. Until 1946, man-made radioactive materials were being produced at a few large research centers in minute quantities by expensive and tediously-operated cyclotrons and other particle accelerators. The uranium reactor developed during the recent war years is capable of producing millions of times the radioactivity induced by the particle accelerators. In fact, the supply of radioisotopes is now adequate to meet the needs of all qualified to use them safely. At the present, this is the chief peacetime contribution of the atomic energy program to our national welfare.

Due to space limitations, detailed nuclear technology and mode of production of radioactive isotopes will not be considered in this paper. It will suffice to say that the great radioisotope production achieved by the uranium reactor, is made possible by the copious supply of neutrons available from the uranium fission reaction. In the heart of the reactor at Oak Ridge, Tennessee, a million million (10^{12}) neutrons pass through any given square centimeter area every second. These neutrons penetrate the nuclei of normal stable atoms and create radioactive ones from them, or cause the uranium atoms to fragment into two radioactive atoms of lower atomic weight. The reactor yields radioactive forms of most of the elements from hydrogen to plutonium.

Radioisotopes are atoms which exhibit identical chemical properties to stable or non-radioactive isotopes, but which have different atomic weights. These radioatoms are in an unstable or excited state and liberate excess energy as ionizing radiations similar to those emitted by naturally occurring radioactive materials. The radiations take the form of alpha particles (the nuclei of helium atoms), beta particles (an electron ejected from the nucleus of the atom), and gamma rays (electromagnetic waves similar to x-rays). Each radioisotope has a characteristic set of radiations and a specific rate of decay or disintegration. The rate of decay, designated as the half-life, is the time required for half of a given batch of radioactive atoms to disintegrate. With proper instrumentation, the scientist can detect and measure the physical properties of a radioisotope and identify it in this manner. The properties associated with a particular radioisotope are established at its formation, and there are no known methods of changing them without modification of the structure of the nucleus of the atom.

Radioisotopes as Tracer Elements

Radioisotopes are excellent tools for tracing materials through physical, chemical and biological systems. As previously stated, they are chemically indistinguishable from the stable atoms of the same element whether existing as ions or as parts of complex molecules. Therefore, they can be counted on to follow the pathways of the specific material to be traced. Because batches of radioatoms emit radiations wherever they

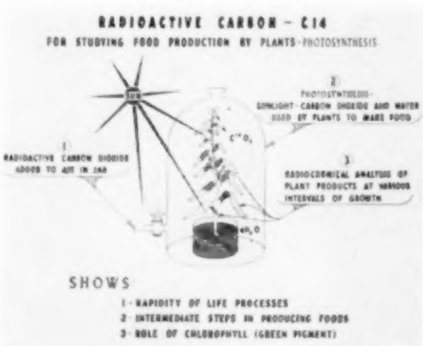

FIGURE 1.

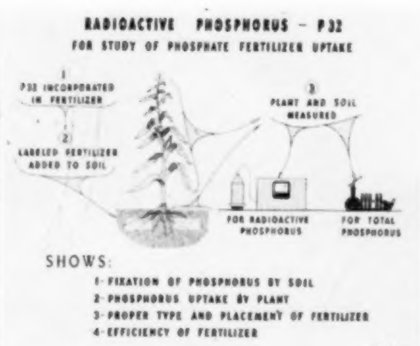

FIGURE 2.

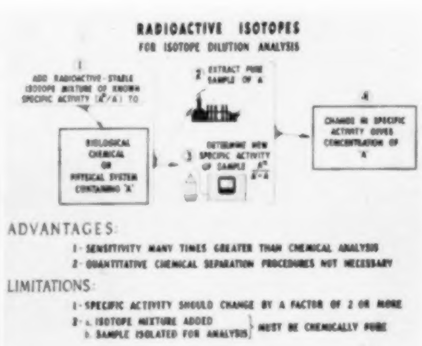

FIGURE 3.

go, signals are constantly being given off as to the radioatoms' whereabouts.

Present day instruments permit the successful tracing of the radioactive atoms even when they are diluted millions of times by stable material. The ability to use such great dilutions of radioisotopes alleviates the possibility of upsetting the normal processes in a given system by radiations from the active material. Tracing by means of radioisotopes is an extremely sensitive method because the radiations emitted are the results of the actions of individual atoms and may be so recorded by the detecting instrument. No other known scientific tool or technique for tracing atoms and molecules can give the specificity, sensitivity and the ease of detection obtained through the use of radioisotopes.

Radioactive atoms as tracers find application in all fields of pure and applied science. In the succeeding paragraphs only a few specific examples can be cited.

The life scientist, in his endeavor to unmask Nature and reveal some of her most closely guarded secrets, is using radioisotopes in the study of living things. Perhaps the most important and interesting of these is a study of the photosynthetic process of green plants—the means whereby simple inorganic materials, water and carbon dioxide, are made into complex organic material through the use of the sun's energy.

Radioactive carbon (C^{14}), as illustrated by *Figure 1*, is being used to ferret out the unknown metabolic pathways the carbon atoms follow in producing the nutrients of life. In this study, plants are allowed to grow in an atmosphere containing carbon 14 as carbon dioxide. After the plant has photosynthesized for varying periods of time, the various fractions of the plant tissue are extracted and analyzed.

Radioactive carbon atoms have been detected in some complex intermediate metabolic products in less than 5 seconds after subjecting the plant to radioactive carbon 14 dioxide. In 60 to 90 seconds carbon atoms are detected in complicated sugar molecules. Thus, the heretofore hidden steps in the production of foods by plants are beginning to yield their secrets.

Perhaps the day will come when man, given enough knowledge, can compete with green plants as a producer of food. This example illustrates the use of a radioisotope in a very qualitative and exploratory fashion.

A more quantitative application of radioisotopes to the problem of following specific batches of atoms and molecules is found in phosphate fertilizer uptake studies. These investigations are being performed by the U. S. Department of Agriculture in cooperation with 15 state agriculture experiment stations. In dollar-and-cent terms, the fate of phosphate fertilizers added to the soil is highly significant to farmers. Prior to the availability of large quantities of radiophosphorus there were no methods of determining what fraction of the phosphate fertilizer actually was absorbed and used by the plants. Now, however, actual field tests can be made with radiophosphorus incorporated in the fertilizer to be studied. The supply of this particular radioisotope is so great that many sorts and modes of fertilizer application can be evaluated.

In this important application, presented in *Figure 2*, the fertilizer to be studied is prepared so that the experimental material is like commercial phosphate fertilizer but has radioactive phosphorus mixed evenly through it. Prior to placement on the soil, the scientist determines the quantity of radioactivity to the weight of inert phosphate. This is usually expressed as specific activity, that is, the number of millicuries (unit of radioactivity) to grams of phosphate material.

The material is then added to soil using normal fertilizing methods. The plants to be tested are grown on the treated field. Periodically during the growing season and at maturity, the phosphate content of the plants and the specific activity of the phosphate samples are determined. If the specific activity, after correction for radioactive decay, is the same as the fertilizer, the researcher knows that all the phosphate absorbed by the plant has been obtained from the fertilizer. If a specific activity lower than that of the fertilizer is found, he reasons that phosphates naturally occurring in the soil caused the dilution of the specific activity.

In a few soils, it was found that the naturally occurring phosphate contributed 95 per cent of the plant phosphate. In most of these cases the farmer had been adding phosphate fertilizer routinely each year.

Figure 4.

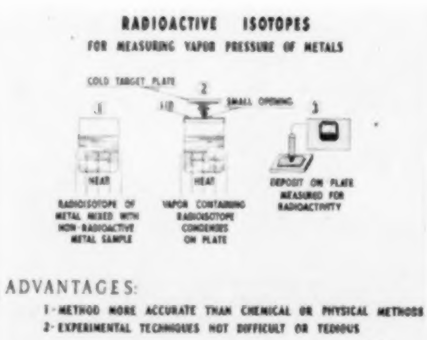

Figure 5.

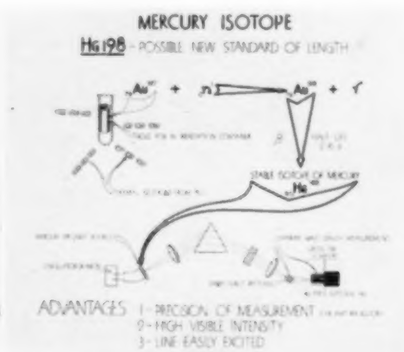

Figure 6.

He now can reduce his fertilizer bill since he knows the soil contains sufficient phosphate for excellent plant growth.

In the field of analytical chemistry many occasions arise where it is difficult or next to impossible to obtain quantitative separations of the material under study. Yet it is possible and fairly convenient to obtain a very pure sample of the material. If radioisotopes are available in proper chemical forms, isotopic dilution analysis may be profitably used. *Figure 3* outlines the method and notes its advantages and disadvantages.

Radioisotopes are aiding the chemist and physicist in obtaining physical data in a more direct and convenient fashion. Two illustrations, *Figures 4* and *5*, show the use of radioisotopes for studying solid diffusion and the measurement of vapor pressure of metals.

The June, 1948, issue of THE SCIENCE COUNSELOR carried an interesting article on the light wave of mercury 198, illustrated by *Figure 6*, as the ultimate standard of length. This paper pointed out another unique application of the ability to make large quantities of man-made radioisotopes.

Natural mercury has seven isotopes. The light from a lamp containing this material will not be monochromatic and for this reason is of little value as a standard. Natural gold, however, has only one stable isotope, gold 197. By neutron bombardment, gold 197 may be changed into radioactive gold 198 which disintegrates into mercury 198. So, mercury of one isotope can be produced. Light from lamps containing this mercury have one wave length and will be constant. Although radioactivity was not used *per se*, this is none the less a significant contribution obtained through radioactivity.

Not only are students of pure science finding radioisotopes useful, but scientists working on practical problems are being assisted. Improved industrial processes are growing out of radioisotope applications. In the transport of crude oil and refined products in pipelines it is economically important to determine the point at which one product leaves off and the other starts, and the degree of intermixing of the two. Using the terminology of the oil trade, such a transition point is referred to as an "interface." Tagged atoms from radioactive barium 140 and its decay product, lanthanum 140, are being used as radioactive signals to sound out alarms precisely when such a transition occurs. By introducing a small quantity of radioactivity into a liquid oil flow, it is possible to determine the interface between two different crudes or refined product stocks in a pipeline and to detect the arrival of the interface at a terminal point miles from the initial site. This technique makes it possible for operating personnel to switch more exactly the flow in a pipe line as the different fluids appear at a pumping station or refinery. The increased efficiency of the process is saving thousands or even hundreds of thousands of barrels of products. *Figure 7* depicts this use.

Radioisotopes as Sources of Radiation

Radioisotopes in a fixed radiation source are being used to gauge the thickness of sheet materials. The essential parts of a radioactive gauge are a radiation source and a suitable radiation meter, shown in *Figure 8*.

The radiations from the source which are able to pass through a given sheet material to the detector is proportional to the thickness of the material. The advantages of the radioactive thickness gauge over conventional mechanical methods are: (1) a rapid and sensitive method for determining thickness of materials, (2) measurements may be accurately made on moving surfaces, (3) no physical contact is made with the material being measured obviating marking of delicate or easily marred surfaces as is the case with mechanical and other contact gauges, and (4) a great range of thickness may be measured by merely changing the radiation source to give the desired intensity.

Perhaps the most dramatic and striking benefits being derived from the use of radioisotopes are those in the field of medicine where they have provided valuable aids in the laboratory study and clinical treatment of diseases. Of immediate importance is their use in the diagnosis and treatment of diseases associated with tissues which selectively concentrate large quantities of a particular radioactive material. This is a

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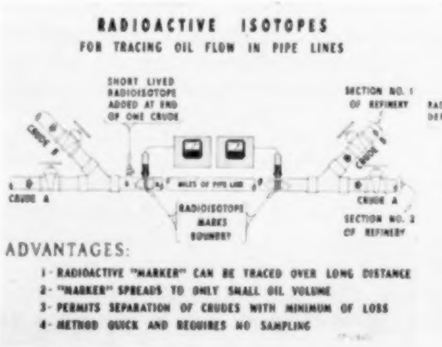

FIGURE 7.

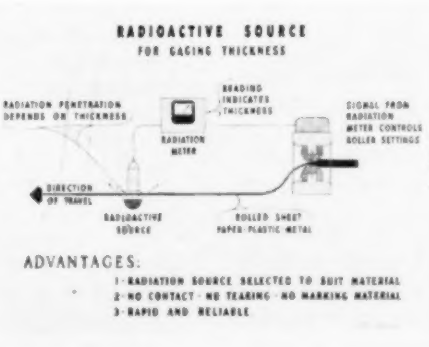

FIGURE 8.

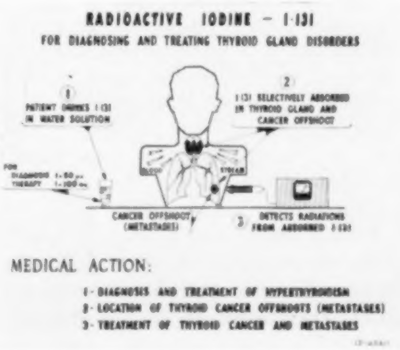

FIGURE 9.

Lecithin

● By W. K. Hilty, B.S., *(Manchester College)*
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This is a story about lecithin, a universal constituent of all living tissues. You see its name among the ingredients listed on boxes of chocolate candy and on the wrappers of oleomargarine. The paint, leather, fur, textile, plastics, and cosmetics industries find this material useful. Recently its value in human and animal nutrition has received attention.

Mr. Hilty tells something of the history of lecithin, how the material is prepared, and of what it is composed. If you read this article, in the future you'll probably examine wrappers of candy bars and the labels of foodstuffs with increased interest.

●

Examine the list of ingredients printed on almost any chocolate candy bar and you will find listed the word "lecithin." All the other substances are more or less familiar and are found on everyone's pantry shelf. But what of lecithin—what is it? Why is it used in candy bars? This article will answer these questions and tell something of the history and use of this interesting but little known substance.

Lecithin is not a new "synthetic" substance. It is as old as life itself, for we know that it is found in all living cells, animal or vegetable, in small quantities in most cases. When animal or vegetable tissues are extracted with ether or with certain other organic solvents, the soluble material consists of ordinary fat together with a variable amount of additional substances. Many of these substances are of a fatty nature and yield fatty acids on hydrolysis, but they differ from ordinary fats in that they contain nitrogen and phosphorous in the molecule.

Ordinary fats are esters of glycerol and fatty acids. They can be visualized as follows:

CH_2OH	CH_2OOCR
$CHOH$	$CHOOCR$
CH_2OH	CH_2OOCR
GLYCEROL	FAT

In a neutral fat each —OH group of the glycerol molecule is replaced by a fatty acid group —OOCR. In the nitrogen and phosphorous containing substances one of the fatty acid groups of a neutral fat is replaced by a combination of phosphoric acid with a nitrogenous base. The molecule becomes:

CH_2OOCR
$CHOOCR$
$CH_2—O\overset{O}{\overset{\|}{P}}(OH)O—(CH_2)_2—N(CH_3)_3OH$

A LECITHIN

The phosphorous and nitrogen containing substances eventually came to be known as phosphatides or phospholipids, although the latter term is seldom used. While several such compounds have been identified, the two best known are lecithin and cephalin. These complex fatty substances were first discovered by Fourcroy, a French chemist, in 1793. Their composition was first established in 1850 by Gobley, who had extracted a nitrogen and phosphorous containing fat from egg yolk which he subsequently called, lecithin (from the Greek γέκνθος, egg yolk). Gobley's product was probably a mixture of lecithin and cephalin. The latter substance was first investigated by Thudicum in 1884. Lecithin and cephalin differ only in the nitrogenous constituent of their respective molecules. In lecithin the nitrogenous base is choline ($OHCH_2 \cdot CH_2N(CH_3)_3OH$); in cephalin the corresponding base is amino ethyl alcohol ($NH_2 \cdot CH_2CH_2OH$).

The two phosphatides lecithin and cephalin which generally occur together are characterized by their solubility in ether and insolubility in acetone. Lecithin is soluble in ethyl alcohol in which cephalin is insoluble. Each contains one atom of phosphorous and one of nitrogen. The compounds are isolated with difficulty. Properly purified lecithin is a pale yellow paraffin-like substance which darkens rapidly on exposure to air. Cephalin, on the other hand, is a powder-like substance. It also darkens when exposed to air. Commercial lecithin is actually a mixture of lecithin and cephalin and other phosphatide substances.

To return to our candy bar, the lecithin in it was in all probability obtained from soybeans, which contain a substantial quantity of phosphatides. They are found in the oil in amounts of from 1.5 to 2.5 per cent. Commercial lecithin is obtained from solvent-extracted soybean oil.

In the solvent extraction process soybeans are passed through rollers which flatten them to thin flakes about one-half inch in diameter. The flakes are transported to an extractor consisting of a totally enclosed chamber inside of which is a series of perforated baskets attached to a pair of endless chains which encircle and are driven by sprocket wheels. The flaked beans are charged automatically into each basket as it starts

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Electroplating Comes of Age

• By Joseph B. Kushner
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The secret art of electroplating as practiced a century ago under the master-apprentice system is herewith briefly contrasted with its modern status as a rapidly developing engineering process.

Mr. Kushner reveals that even our daily lives are affected by electroplating.

The multitude of its present day applications will astonish many readers.

A little over a hundred years ago, *circa* 1836, electroplating had its first commercial beginning when an English silversmith named Elkington, received a letters patent on a method for coating base metals with silver by electro-deposition from a cyanide solution. From this somewhat inauspicious start, electroplating has grown and developed as an applied science until today it has become the handmaiden of a hundred and one industries and is importantly responsible for many of our daily necessities and luxuries.

For example, the type used to print this journal or your daily newspaper is produced by an electroplating process (electrotyping). The recording of "Mule Train," or of whatever form of music you enjoy playing, was manufactured by stamping dies made by an electroplating process (electroforming). The rubber tires on your car are formed in molds made by electroforming. Glass bottles and plastic items galore are produced by molding in dies that have either been made by electroplating or, if not, at least faced by a chromium plate. You can go to the notion counter of your favorite Five-and-Ten and find beautiful metallic buttons and novelties by the thousands, that have been made by plating on plastics.

The stock that makes up the lowly tin can is produced nowadays by electroplating tin onto a rapidly moving ribbon of sheet steel at speeds well in excess of 500 ft. per minute. Electroplating is responsible for the long life of our present-day aviation engines—the chrome plated cylinder liners outwear the unplated ones by ten to one—and the silver, lead and indium plated bearings show a similar longevity. Copper and nickel sheet, copper and nickel screens, gold leaf and silver foil are directly produced by electroplating. Metallic powders used in the growing field of powder metallurgy are produced that way also. The bells of trumpets and trombones and the bodies of kettle drums are made by electroplating. Electroplating in reverse, a process called electropolishing, has so greatly lowered the high cost of polishing stainless steel and other metals that you can now obtain brightly polished kitchen gadgets at much lower prices than formerly. Costume jewelry, rust prevention of machine and metal parts, decorative finishing from automobile bumpers to xylophones, are all within the province of electroplating. It can be truthfully said that we come into contact with electroplating at every stage of our lives from the chromium plated delivery forceps to the electroformed copper casket!

On looking over the history of this truly ubiquitous applied science that has been neglected by our secondary schools and institutions of higher learning, one is struck by the fact that most of these developments have taken place in the past two decades. The reason is not hard to find. In early days, electroplating was considered a mysterious art. Practitioners of the art handed down the "secrets" from father to son. The mysteries of the craft were more zealously guarded than today's atom bomb. A man who would undertake this kind of work had to have a good constitution, an observing eye, and unlimited patience.

A good constitution was a definite requisite because the early shops were unhealthful places. They were dimly lit. They had foul smelling, steaming, dank atmospheres and floors that resembled "the old swimming hole." That the "plater" was not killed by pneumonia, tuberculosis, or just plain poisoning is truly a tribute to the resiliency of the human body.

The plater needed an observing eye because the master of the art spared no pains to keep secret the knowledge he possessed. The early pioneers tested their plating solutions by the simple expedient of tasting them. Believe it or not, even cyanide solutions were tested that way! How was an apprentice to know whether or not the solution was satisfactory unless he caught the master's reaction out of the corner of his eye, and observed the surreptitious dumping of this or that into the plating bath. Under such circumstances the need for infinite patience by the learner can readily be appreciated.

In those days discoveries were usually purely accidental. Thus, John Wright, a worker in Elkington's Birmingham silversmithing shop who had one evening inadvertently contaminated a silver plating bath with carbon disulphide, found the next day that the supposedly spoiled plating solution was giving a brighter deposit of silver than ever before. He sold his discovery to his employer, and it probably would have remained a secret yet if another sharp-eyed worker hadn't learned of it and promptly sold the secret to Elkington's bitterest competitor, the following week. Perhaps the best example of such accidental discoveries, however, was the case of the plater who lost his false teeth in his nickel plating bath and then found that

(Continued on Page 40)

Garden Farming in Japan

• By C. L. W. Swanson, Ph.D., *(Iowa State College)*
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This paper is written from first-hand knowledge. The writer recently spent considerable time in Japan studying the agricultural situation. His observations and conclusions will interest you.

Are Japanese agricultural workers farmers or gardeners? Can Japan grow enough food to feed her people? Why is so little land cultivated? What about soil fertility and fertilizer consumption? What effect did the atomic bombings have on crop yields?

Read, and find out.

Popular articles often state that Japanese farmers are the best farmers in the world. This statement is only a half-truth, for agriculture in Japan is gardening (Figs. 1, 2, 3, and 4) rather than farming. The fields are plot-sized (Figs. 1 and 2), and most of the work is done by hand with rather primitive tools (Figs. 3 and 4), usually well suited to their use. Because of the scarcity of cropland and the poor economic conditions in his country, the Japanese farmer has to be a good farmer or face food shortages and ruin.

Because of unlimited labor sources, little regard is given to the amount of labor expended in growing crops. Figuratively speaking, each plant receives individual attention. Consequently, production per unit area is high but production per man is low. For example, rice yields are twice and three times as large, in some instances, as those in other major rice-producing countries. If as much individualized time and effort were given to the growing of crops in the United States, combined with our present modern agricultural practices, yields for similar crops would probably reach levels much higher than those obtained in Japan.

Fig. 1. Typical farmstead in Kyushu. Note rock walled terraces and rice straw stacks. The land has been prepared for non-irrigated fall wheat.

The area of Japan is about 147,000 square miles or approximately the size of Montana. On this area live about 80,000,000 people; a density of 540 persons per square mile for the total area, or 5,330 persons per square mile of cultivated area. The preponderance of hilly and mountainous terrain sets definite limits to the cultivated area and explains why no more than 15 million acres or 16 per cent of the total area of Japan is cultivated. On this land area, the farmers of Japan have provided 80 to 85 per cent of the annual food requirements for their country during the past 20 years. Food deficiencies were made up by imports. With increased demand for food due principally to a rapid rise in population (69,000,000 as the 1931-1940 average), it cannot be expected that Japan will produce sufficient food now to feed her people.

Physiographic Land Pattern

Japan is a mountainous country, a solid backbone of mountains running through each of the main islands. About 75 to 80 per cent of the area is hilly or mountainous land. Many of the mountains rise to heights of more than 8,000 feet, there being 18 important peaks of such heights, including Fuji-San with an elevation of 12,396 feet. The streams are short and rapid.

Japan lacks extensive plains or lowlands. Along great stretches of the coast, plains are absent and the hill lands reach down to tidewater. Numerous small plains occur in the mountain basins. The typical coastal plains are small, rarely extending more than 30 miles inland. The most important of these plains is the Kwanto (or Kanto) Plain comprising an area of about 3.5 million acres. Tokyo is located on this plain.

Climate and Vegetation

No part of Japan suffers from a yearly deficiency of rainfall, but occasionally droughts occur. There are no winter-dry climates. In general, precipitation increases from north to south; the precipitation for the entire country ranges from 30 to 100 inches.

Originally, Japan was a wooded country and even today, about 60 to 65 per cent of the total land area is classified as forest land. Broadleaf forests predominate, occupying about 40 per cent of the total forested area; coniferous and mixed forests are about equally divided, occupying 24 and 23 per cent, respectively.

Japanese forests have a dense undergrowth, reflecting heavy rainfall and high temperatures during the growing period. Dwarf bamboo (sasa) is widespread on the forest floor. In the extreme southern part of Kyushu are found numerous tropical trees and vegetation, such as palms and

banana trees. Many of the river valleys in northern and eastern Hokkaido are wet, tundralike areas.

About 12 per cent of the land is in pasture and genya land. The term *genya* is translated in various ways—wild land, wasteland, prairie, meadow, pasture—but essentially it is treeless land, most of which will revert or be planted to forest. There are no areas of prairie such as are found in the United States and Russia.

Soils, Cropping and Fertilizing Pattern

The rugged relief is one reason why large areas of fertile soils are not found in Japan. The slopes are too steep to allow the formation of deep, relatively fertile, productive soils.

The most important and most fertile soils of Japan, which support the bulk of the population, are the alluvial soils developed in the lowlands. On these, paddy or irrigated rice is grown during the summer (Fig. 2), and in southern Japan during the winter months, these soils are also cropped to wheat or barley.

The farm land of Japan falls into two main groups—rice fields (irrigated land) (Fig. 2) and upland fields (non-irrigated land) (Fig. 1) which are devoted to other crops. A little more than half of the cultivated land is in paddy rice; barley (both covered and naked), wheat, white potatoes, sweet potatoes, vegetables, and fruits are the important upland crops. On a large part of the land two successive crops are grown each year. Two crops of rice are rare, but much of the irrigated rice land is replanted (double cropping) to winter crops, such as wheat or barley. Multiple cropping of land is practiced widely in central and southwestern Japan. A succession of an early vegetable, a late vegetable or buckwheat, and wheat or barley is common on the upland areas. Because of this practice the area of cropped land is nearly 40 per cent greater than the area of arable land.

For maximum crop yields, most of the soils of Japan require heavy fertilization and liming. Fertilizers are of real importance because of the intensive agriculture and because the scarcity of agricultural land makes it important to secure high yields from every crop grown. Because large amounts of commercial fertilizers, barnyard and green manures, composts, and night soil have been applied to crops, the soil fertility trend on agricultural lands is upward.

Examination of world fertilizer consumption statistics shows some very interesting comparisons. When a comparison is made of the average amounts of commercial fertilizers consumed by the world's major agricultural countries during 1935-1937, in terms of pounds per acre of arable land, Japan was third in the total amount of nitrogen (37.4 lbs.), fifth in phosphoric acid (34.4 lbs.), and fifth in the total amount of potash (15.1 lbs.) consumed. During the same years, the United States ranked 22nd in the use of nitrogen (2.1 lbs.), 24th in phosphoric acid (4.4 lbs.), and 19th in amount of potash (2.0 lbs.) consumed. On the basis of world distribution of arable land, Japan ranked 19th and the United States second. The comparison today would be somewhat different for fertilizer consumption has increased tremendously in the United States beginning about 1942, but the comparison does show the importance fertilizers have in the production of food in Japan.

The Major Food Crops of Japan

About 85 to 90 per cent of all the food (in terms of calories) grown in Japan has been furnished by the crops rice, wheat, naked barley, covered barley, sweet potatoes, and white potatoes.

Rice is by far the most important food crop, providing over 50 per cent of the average caloric intake. It is used at practically every meal, and, although other grains also are consumed, they supplement rather than replace rice. Rice became the dominant food crop because, under Japanese conditions, it yielded more calories per unit of land than any other cereal.

Wheat is the second most important cereal, followed by naked barley and covered barley. Next in importance to the cereals in providing calories for the Japanese diet are sweet potatoes and white potatoes. In recent years the potato acreage has increased, with the gain about equally divided between the two kinds of potatoes. In 1945, however, the increase in sweet potato acreage was about ten times that of the white potato acreage increase.

Vegetables, fruits, and other miscellaneous plant-grown food crops, fish, poultry, and animal products make up other sources of food for the Japanese people.

Increase of Arable Land Area by Reclamation

There is still some land in Japan, however, that could be put into crops. The Japanese Government has prepared a 15-year plan for the reclamation of about 4,100,000 acres, beginning in 1945. Nearly half (43 per cent) of this land is located in Hokkaido; here a considerable portion of the area consists of peatbeds and marsh lands. Much of the area is in Honshu, Shikoku,

FIG. 2. Japanese farmers pulling up rice seedlings for transplanting to other fields. The two fields in the top part of the photograph have just been planted to irrigated rice. Cheap and abundant labor allows individualized attention for the growing and harvesting of rice, Japan's principal agricultural crop.

FIG. 3. Preparing land for fall wheat in Japan. The implement is used for breaking up the soil clods.

and Kyushu and supports forests and low-growing brush. Apparently, many intermontane areas in Japan at elevations of 4,500 to 6,000 feet are suitable for the growing of cereal crops, white potatoes, vegetables, and pastures, but have been little used for crop production.

Only about 10 per cent of the area can be utilized as paddy (irrigated) rice land; the other 90 per cent will be non-irrigated land, generally of lower quality than lands already in production. The most productive land to be put into cultivation (13 per cent) is found on former military areas which occupy relatively smooth terrain.

Although plans for reclaiming an area equivalent to about 25 per cent of the land now in cultivation is unquestionably highly optimistic, it is interesting that all of the land which might be cultivated is not being used for crop production purposes. However, it appears that most of the desirable land is already in use, most of the reclaimable land left is inferior to the land now in cultivation, the cost of reclaiming some land is prohibitive, and land which is not suitable for reclamation has been included in the program.

Even though it is possible to increase the arable land area of Japan, the additional food crops harvested from this potential area are not expected to alleviate food shortages in that country altogether. Less food will be produced through reclamation of land to crops than estimated by the Japanese Government. If the reclamation project is completed by 1960 as planned, it has been estimated that Japan will still have a food deficit, and that about 25 per cent of her food will have to be imported. One large factor causing this deficit is the large estimated increase in population—80 million to 92 million in 1960.

Effect of Rice Culture on Land Use and Soil Conservation

In Japan more importance has always been placed on the growing of irrigated rice than on upland crops. Practically all land areas where water can be got onto the land in some way, no matter what the expense or labor cost, is in paddy rice. Only a small amount of land exists now which can be reclaimed for paddy rice growing, while on the other hand, quite extensive areas can be found on which upland crops may be cultivated.

One usually thinks of Japan as a country that practices good soil husbandry. Probably no country takes better care of her rice lands than does Japan. Japanese farmers are among the best rice growers in the world[1]. They spare no labor in growing the crop. In many areas, in order to get more land for the growing of rice, especially in central and southern Japan, they have built elaborate terraces often of stone requiring many hours to construct. But these terraces apparently were not put up only for the purpose of holding the soil in place; they were built also so that the land would be made level. Water could then be directed on the land and irrigated for rice culture. It is true that dry-land crops such as wheat, barley, and vegetables are grown on this terraced land but they are grown usually after the rice has been harvested. A rice and wheat or barley alternation of crops is common in Japan.

The high priority given rice over that of other crops in Japan evidently has had its effect on upland cultural practices. *The meticulous care and arduous labor devoted to the rice paddy fields were not likewise spent on upland fields.* Since rice is the main food in Japan, attention has been focused on its production by both the Japanese farmer and the Japanese Government. *In many areas it is not difficult to find upland fields with slopes of 30 per cent or more in cultivation.* Such areas were observed in Hokkaido, northern and southern Honshu, and southern Kyushu. Crops were being planted up-and-down the hill and soil losses were evident.

Up to the present, erosion control in Japan has been largely negative, dealing with the repairing and restoration of eroded country, especially if it affected rice production. A growing school of thought is now advocating that erosion control methods be established before erosion begins. In some

(Continued on Page 30)

FIG. 4. Preparing the land with hand tools for fall vegetables in Kyushu, Japan. A good example of garden farming technique used in Japan.

[1] According to an article by L. T. Willahan entitled "Rice—A World Food Crop" in *Foreign Agriculture*, Vol. 12:115-120, 1948, Spain, Italy and Australia outproduce Japan on average yields per acre of rough rice. Spain's highest reported average yield was 124.4 bushels per acre while the yield for Japan was 75.8. Japan, however, was the third largest world producer of rice before the war (1935-1939) in comparison to the relatively small total production of Spain.

A Step in Industry-Education Cooperation

• **By Nathan A. Neal, M.A.,** *(Columbia University)*
HIGH SCHOOL TEXTBOOK DEPARTMENT, HARPER & BROTHERS, NEW YORK, NEW YORK. PRESIDENT, NATIONAL SCIENCE TEACHERS ASSOCIATION

"Industry has a real stake in good science teaching, and science teachers have much to gain from industry. In bringing these two groups together for study and action on mutually important problems we are helping to close the traditional gap between classrooms and the world of science and technology."

This statement by Dr. Morris Meister suggests what the National Science Teachers Association is doing to improve industry-science teaching relations through its Advisory Council, its National and Regional Conferences, its Packet Service, and in other ways.

In this article, NSTA President Neal describes some of the phases of current industry-science teaching cooperation. Cooperation is of major importance to both groups.

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The importance of cooperation between industry and education has long been recognized in THE SCIENCE COUNSELOR* and other professional journals for science teachers. A scattering of graduate studies over half a century have listed, evaluated, and recommended lists of free and low cost pamphlets, charts, pictures, models, and exhibits available from industry for classroom use.

The original constitution and by-laws of the National Science Teachers Association, framed during the September 1944 meetings of the American Association for the Advancement of Science, recognized the importance of such cooperation through a provision for institutional or industrial membership. The brief history of NSTA has included continuous active cooperation with manufacturers and other branches of industry. This discussion will deal with some of the aspects of this industry-science teaching cooperation.

During the early days of NSTA a grant was received from the Consumer Education Study to finance a committee on The Place of Science in the Education of the Consumer. The aim of this committee is indicated in the two chief purposes of the Consumer Education Study, namely: (1) To investigate what should be taught and how it could best be organized and objectively presented; (2) To facilitate the work of the schools by providing instructional materials.

The committee's report, published in 1945, dealt with the need for consumer education, the relation of science to consumer education, illustrative material for use in consumer education, curriculum organization, teaching methods, and proposals for further action. In its suggestions for next steps for science teachers, the report recommended among other things a study of possible standardization procedures for the physical specifications and advertising content of free and low cost supplementary materials provided by industry for school use.

In carrying out this recommendation a larger grant to finance a more elaborate investigation was obtained from the Consumer Education Study.* The scope of the 61 page report of this committee, "Specifications for Commercial Supplementary Teaching Materials for Science," is indicated in its table of contents: The Use of Commercial Supplementary Materials in the Teaching of Science; Suggested Advertising Practices in Commercial Supplementary Teaching Materials for Science; Suggested Physical Specifications for Commercial Supplementary Teaching Materials for Science; Suggestions of Content for Commercial Supplementary Teaching Materials for Elementary School Science; Suggestions of Content for Commercial Supplementary Teaching Materials for Health Education in the Elementary Schools; Suggestions of Content for Commercial Supplementary Teaching Materials for the Biological Sciences in the Secondary School; Suggestions of Content for Commercial Supplementary Teaching Materials for the Physical Sciences in the Secondary School; Suggestions for the Implementation of the Report. This report has had wide and favorable acceptance in numerous industries which provide significant materials for classroom use. This is not to say that all the recommendations of the Report have been universally accepted. However, the tendency toward standardization in terms of optimum school use is more evident today than at any previous time.

The volume of correspondence which arose from the distribution of the second NSTA report in the area of industry-education cooperation led to the calling of a meeting in December 1947 of industry-education representatives. This First Conference on Industry-Science Teaching Relations was held during the annual winter convention of the AAAS and affiliated societies. Subsequent conferences were held during the December NSTA conventions of 1948 and 1949. The large attendance from representatives of industry at these meetings attests their sincere interest in providing more and better supplementary materials for use in science teaching and other subject matter areas.

A major recommendation of the 1947 cooperative conference was for the formation of an Advisory Council on Industry-Science Teaching Relations. This Advisory Council was formed early in 1948. It is composed of ten representatives of industry and ten science educators. Its continuing purpose is to promote good science teaching by improving industry offerings and by teaching teachers to make the best use of this material

* "Schools and Industry Cooperate"—J. Fred Essig, *The Science Counselor*, Sept. 1949. "A New Service for Science Teachers"—Bertha E. Slye, *The Science Counselor*, December, 1947.

in the classrooms of the nation. Dr. Morris Meister is chairman of the Advisory Council. In a recent publication[1] Dr. Meister has made the following statement:

> "Industry has a real stake in good science teaching, and science teachers have much to gain from industry. In bringing these two groups together for study and action on mutually important problems, we are helping to close the traditional gap between classrooms and the world of science and technology. The goal is twofold: to assure a continuing supply of trained scientific personnel, and to develop citizens who are better informed concerning the part that science is playing and can play in modern times. In the last analysis, the growth of science, upon which the future of our country depends, will be determined by how the people vote and what ideas they choose to support."

It was agreed when the Council was organized that it would have continuing membership and leadership for the first three years. The vigorous program of the Council speaks for the wisdom of this decision. It is safe to say that the group has functioned with increasing efficiency and mutual understanding in each of its six one- or two-day conferences.

During the two years of its existence, the Advisory Council has developed a program of cooperation with industry which includes: *consultation* in the planning of classroom materials; *evaluation* of the printed materials which are ready for use; *distribution* of packets of materials from industry to members of NSTA and affiliated groups; *suggestions for utilization* of these classroom materials; *research* in the area of needs for educational materials from industry; and national and regional *conferences* which bring science teachers and representatives of industry together for discussion of problems of mutual interest.

Under the present plan of consultation service, the Executive Secretary maintains a file of competent NSTA members with specialized interests in many fields of science. Arrangements for *actual* consultation service and agreements as to the work and compensation are made by the client or clients and the consultants recommended by NSTA. The National Science Teachers Association assists in facilitating these arrangements, but it is understood that the consultation agreement is a private matter between company and consultant.

An example is the conference recently arranged at the request of representatives of the Better Light Better Sight Bureau and worked out in detail through the cooperation of the NSTA Executive Secretary Robert H. Carleton and representatives of the Bureau. The conference was attended by three representatives of the Bureau, six NSTA consultants, and Mr. Carleton.

The prospectus for a 9th grade teaching unit in the area of light and vision was presented by the Bureau representatives. This served as the basis for discussion by the entire group. Ideas, suggestions, and proposals were introduced and considered in terms of classroom use. As a result of this typical procedure an up-to-the-minute publication sponsored by this industrial group and guided by consultation with educators is likely to be made available. Items prepared with the help of consultants recommended by NSTA are subject to the same procedures of evaluation as any and all other items prepared independently.

Evaluation of industrially sponsored materials is an established procedure prior to distribution to NSTA members. Evaluation consists essentially of the examination and rating of materials to determine their suitability, acceptability and effectiveness for use in science teaching. Evaluation is confined to items already prepared or printed and ready for distribution. Items in prospectus form, in manuscript, in galley proof or in page proof may receive attention from NSTA consultants if requested.

Final decision as to whether an item is deemed "educationally useful and acceptable" rests with the Chairman of the Advisory Council and the Executive Secretary, but is based upon the composite ratings returned by the evaluators.

Types of items evaluated range from comic book versions of industrial processes to technical material of reference value to teachers in specialized fields. In general, the most usable items are those which are limited to specific topics. Evaluators are impressed with publications which include pictures, diagrams, and other clear-cut evidences of scientific progress. However, a variety of materials including A Power Primer, Trees of Tomorrow, An Outline in Aluminum, Five Years of Synthetic Rubber, Applications of Atomic Power, Air Transportation, Nutritive Value of Vegetables, History of Gas, Plastics: Story of an Industry, Contribution of Petroleum to Farm, Home and Industry, Studying Life to Protect Life, and Know Your Watersheds, to mention a few, have been accepted. About 15 teacher evaluators examine and vote on the acceptability of each item which is considered.

The distribution of industrial materials to NSTA members is carried on through what is known as the Packet Service. To date, 12 Packets of evaluated and approved materials have gone to NSTA members as one of the regular and continuing membership services of this organization. Packets have averaged about six items each, and altogether about 60 educationally minded industries have cooperated in supplying materials and in providing for the cost of distribution to NSTA members. In some cases Packets have included samples of items which are in transition from laboratory development to commercial distribution. An example is the definitely usable sample of Monosodium Glutamate contained along with descriptive literature on its development and use in Packet XII.

In many cases information which will not be standardized in textbooks for years to come is made available to science teachers through the Packet Service. In some cases special industry mailings of large size charts which could not be placed in the packet envelope have gone to NSTA members directly from the source. All such samples and supplementary teaching materials

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[1] Report of Proceedings, Regional Conference on Industry-Science Teaching Relations, Mellon Institute, Pittsburgh, Pa., September 30, 1949.

Anhydrous Ammonia Comes to the Farm

• **By W. B. Andrews, Ph.D.,** *(Michigan State College)*
AGRONOMIST, MISSISSIPPI AGRICULTURAL EXPERIMENT STATION, STATE COLLEGE, MISSISSIPPI

Three years ago it was announced that anhydrous ammonia can be applied to farm land as a direct fertilizer to such good advantage that it is becoming one of the leading sources of nitrogen where it has been introduced. Surprisingly, the ammonia is not quickly leached from the soil since it forms solid ammonium compounds with clay and organic matter.

This paper from the institution where the pioneering research was conducted, describes this new and interesting agricultural advance. The use of ammonia as a fertilizer will undoubtedly expand rapidly when its advantages are appreciated.

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On March 7, 1947, after three years' research, the Mississippi Agricultural Experiment Station released information on the value of anhydrous ammonia for crop production, and on machinery for its application to the soil. Since then the farmers of Mississippi have used:

2,253 tons of anhydrous ammonia between March 7 and June 30, 1947,
12,873 tons from July 1, 1947 to June 30, 1948,
27,433 tons from June 30, 1948 and June 30, 1949.

In 1948-1949, anhydrous ammonia supplied 38 per cent of the total nitrogen used as materials, as compared to 33 per cent for ammonium nitrate and 20 per cent for nitrate of soda.

A considerable amount of anhydrous ammonia has been used in Arkansas and Louisiana, and its use has spread into Alabama, Georgia, Kentucky, Missouri, Tennessee, and Texas. The 27,433 tons of anhydrous ammonia used last year in Mississippi is capable of producing nearly 20 million bushels of corn or 500,000 bales of cotton, which gives some idea of the job which anhydrous ammonia has done for the farmers of Mississippi.

Anhydrous ammonia is a gas at atmospheric temperature and pressure. It boils at 28°F. below zero. It has a pressure of 197 pounds per square inch at 100°F. Liquid anhydrous ammonia is at its boiling point at all times.

Anhydrous ammonia is made from air, steam, and natural gas. It contains 82 per cent nitrogen. It may be used to make solid sources of nitrogen, or it may be used directly. If used directly, the cost of manufacturing solid sources of nitrogen is eliminated.

Anhydrous ammonia is shipped in 26-ton tank cars, and stored in bulk plants at the railroad station or on the farm. It is transported from the bulk plants to the field in 1000-gallon trailer tanks and applied to the land from 100-gallon tractor tanks which hold nitrogen equivalent to 2500 pounds of nitrate of soda. Anhydrous ammonia is transferred from tank to tank by compressors and pumps, and by its own pressure. It is made, transported, stored, and applied without once being picked up or touched by man.

High pressure storage tanks are tested at 400 pounds pressure per square inch before they are used for anhydrous ammonia. Strong tanks, pop-off valves set to be fully open at 250 pounds per square inch, and provisions for preventing filling the tanks to more than 85 per cent of capacity, make anhydrous ammonia a safe product to handle. Only one fatality has been reported in Mississippi, yet the time involved in handling the ammonia would equal 300 years of one man's life.

When gaseous anhydrous ammonia is applied to the soil, it combines with the clay and organic matter to make ammonium clay and ammonium organic matter. These are solids just like ammonium sulphate. The ammonia content of ammonium clay is very low as compared to that of sulphate of ammonia; that is, it might take 500 tons of soil to hold as much nitrogen as is contained in one ton of sulphate of ammonia.

So long as nitrogen is in the ammonium form it does not leach out of the soil. In fertile soil in the Spring, ammonia is changed to nitrate nitrogen in from four to six weeks. Nitrogen leaches only in the nitrate form.

Many young plants, cotton and corn particularly, prefer ammonium nitrogen, and they grow more rapidly when nitrogen is supplied in this form. Older plants prefer nitrate nitrogen; however, in our experiments,

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Applying Anhydrous Ammonia as a side dressing to young cotton.

Counseling Students About Careers In the Physical Sciences

● By Thomas E. Christensen, Ed.D., (*Harvard University*)
DIRECTOR OF GUIDANCE SERVICES, PUBLIC SCHOOLS, WORCESTER, MASSACHUSETTS

Here is immediate help and wise counsel for science teachers and others engaged in vocational guidance who must advise students about careers in the physical sciences.

Expressed pupil interest and teachers' marks are not reliable guides. There are, however, standardized tests for the appraisal of interest in the scientific professions and for predicting successful careers. The most useful of these are discussed by Dr. Christensen. He points out that excellence in mathematics and English are essential, as well as proficiency in the physical sciences. He lists several sources of information concerning specialties within the various scientific fields.

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College and university enrollment statistics show that within the next few years a record number of trained people will be entering the scientific professions. For example, 749 doctor's degrees in chemistry were conferred by institutions of higher education in 1948-49 [5]. Competition for jobs in science will be keen. There is a decided trend toward requiring more advanced study for entrance into the scientific professions. Young people, therefore, are advised to select scientific careers on the basis of their interests and aptitudes rather than upon considerations of economic outlook[1].

What are the interests and aptitudes of young people who are likely to succeed in the scientific professions? No categorical answer can be given to this question. Each individual is the unique combination of a variety of general traits. He is also the product of various situational factors; e.g., the type of high school attended[2]. These personal and situational factors are so interrelated and so complex that prediction of likelihood of success in various fields should be made by counselors trained in differential psychology.

Because a student *says* that he is interested in becoming a scientist does not mean that he is *actually* interested[9]. Many young people who "liked their high school science courses and therefore enroll in similar college courses find out that they have a layman's interest in science and not a technician's. Furthermore, because a student receives high grades in his high school science courses, it does not follow that he has the characteristics of a scientist"[9].

The grades of the science teacher are not equivalent to performance on the job; e.g. securing patent rights for an invention. School marks are based upon a number of variables—the proverbial bringing apples to the teacher is an illustration of what is meant by a variable. Grades are subject to still another limitation: they estimate a student's performance in relation to a specific group in a specific school. They do not compare his performance with that of other individuals taking similar training in other schools. Expressed interests and teacher's marks should therefore be viewed only as rough estimates of interest and aptitude for a career in the sciences. Consideration must also be given to *measured* interests and aptitudes.

Interests of Scientists

The leading measures for the appraisal of interests are the Strong Vocational Interest Inventory[4] and the Kuder Preference Record[3]. Super[7] has recently contributed a valuable appraisal of these instruments.

The *Strong Vocational Interest Inventory* has been standardized on the basis of the interests of successful adults. It furnishes an analysis of the extent to which an individual's likes and dislikes are comparable with those of successful men or women in particular occupations. It is useful for working with high school seniors and college freshmen. The young man who expresses an interest in a career in science may compare his interests with those of successful chemists, mathematicians, and math-science teachers who have taken the test. The young lady who expresses an interest in teaching sciences may compare her interests with those of high school teachers of mathematics and science.

The composition of these criterion groups is as follows:

MEN

Chemist (293 and 297). Members of the American Chemical Society: college professors not included. Primarily from the Middle Atlantic, Great Lakes, and Middle Western states. Average age—35.2 years; average education—16.9 grade.

Mathematician (181 and 181). So designated in American Men of Science; college professors included. Average age—46.1 years; average education—18.8 grade.

Mathematics-Science Teacher (228 and 237). Includes high-school teachers of mathematics and of the physical and biological sciences. These blanks are from the state of Minnesota, obtained through T. J. Berning of the Department of Education of Minnesota. Average age—33.6 years; average education—16.4 grade.

WOMEN

Teacher of Mathematics and Physical Sciences in High Schools (223 and 247). Representative superior and average teachers on the Pacific and in New York City. Average age—39 years; average education—16.6 grade.

The *Kuder Preference Record* measures the interests of boys and girls in ten interest fields: outdoor, me-

chanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical. It is used to measure the interests of high school and college students. The male student who expresses an interest in science as a career may compare his measured interests on the Kuder inventory with those of a group of 56 chemists and metallurgists, 43 chemists, 13 metallurgists, 28 chemical engineers and 30 high school teachers of science. The limited number of cases included in these occupational groups indicates one of the limitations of the Kuder in comparison with the Strong. However, the Kuder may be scored quickly by the student who takes the test, whereas the Strong requires considerable time for hand scoring or must be scored by machine. It is therefore the more expensive to use. Nevertheless it is well worth the extra cost.

Measures of Aptitude for Careers in Science

Strong[4] emphasizes that while interest inventories are valuable for suggesting the *direction* which a student may take, they do not indicate *how far* he will go. Objective aptitude and achievement tests are useful for suggesting the latter. Numerous articles dealing with the use of objective tests in the prediction of academic success have appeared in professional psychological journals. Travers[8] has recently summarized the most significant of these studies. His discussion of the prediction of college and graduate achievement in individual subject matter fields is of especial assistance to counselors of students interested in careers in science. Stuit's[6] summary of research pertaining to the prediction of success in engineering schools is also helpful since the first year of engineering training resembles in many ways the first year at a major in science. Super's[7] recent volume on "appraising vocational fitness by means of psychological tests" summarizes several studies concerned with the prediction of success in the sciences. From the data reported in these summaries the following conclusions may be drawn:

1. The quality of an individual's previous academic record appears to be one of the most reliable bases for estimating his chances for doing successful work in science courses.
2. Tests of general scholastic aptitude furnish additional sources of information regarding a student's potential capacity for success in science courses.
3. Demonstrated proficiency on objective mathematics achievement tests is one of the best indicators of likelihood of success in science courses.
4. There is a significant relationship between achievement in science, as measured by objective tests, and success in science courses.
5. English usage ability correlates significantly with achievement in the first year of engineering training. One may reasonably expect that it should also receive attention in appraising a student's potentialities for training in the sciences. If he has a limited vocabulary and a poor command of English grammar, he will be handicapped in reading technical literature and in preparing descriptive reports.
6. Correlation ratios between scores on interest inventories and grades in scientific courses are generally low. However, interest inventories may aid the student to crystallize his thinking, to validate his claimed interests, or to reveal latent interests.
7. Reliance cannot be placed on any one of the above items to predict likelihood of success in science courses. The use of all of these indexes in *combination* plus other pertinent data should assist in improving the accuracy of prediction of success in courses in science.

These observations are limited to predictions of success in *training courses* because of the limited research concerned with success on the job. However, unless an individual can achieve success in the requisite training courses, he is not likely to become a professional scientist. The essential qualifications for success in science courses and recommended tests and standards are presented in the accompanying table.

ESSENTIAL QUALIFICATIONS, AND RECOMMENDED PREDICTIVE TESTS AND STANDARDS FOR SUCCESS IN PHYSICAL SCIENCE TRAINING COURSES*

Essential Qualifications	Recommended Tests and Standards
Superior aptitude for college and graduate work.	Graduation in top third high school class: (1) ACE Psychological examination for College Freshmen (2) Ohio State University Psychological Test
Proficiency in Mathematics	Grades of B or better in high school mathematics courses Cooperative General Achievement Tests: Test III, A Test of General Proficiency in the Field of Mathematics
Proficiency in English	Cooperative English Test: Test A Mechanics of Expression
Proficiency in the Physical Sciences	Grades of B or A in high school physics and chemistry courses. Cooperative General Achievement Tests; Test II, A Test of General Proficiency in the Field of Natural Science
Demonstrated aptitude for the study of sciences	Iowa Placement Examination: Chemistry and Physics
Interests typical of successful scientists	Vocational Interest Blank for Men, Form M. Score of A or B on Chemist or Mathematicians, or both. For prospective science teachers —A or B on Math-science Teacher Vocational Interest Blank for Women. For prospective math-science teachers—A or B on Math-science scale. Kuder Preference Record —high scores on Scientific and Computational scales.

* Adapted from a similar table developed by Stuit[6] for picturing the essential qualifications for success in engineering.

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COAL---A Vital Factor in Modern Industry

• By M. Edmund Speare, Ph.D., *(Johns Hopkins University)*
EDUCATIONAL DIRECTOR, BITUMINOUS COAL INSTITUTE, (A DEPARTMENT OF THE NATIONAL COAL ASSOCIATION), WASHINGTON, D. C.

Nowadays, no American can be unaware of the importance of the coal industry in the country's economy.

This paper discusses the history of coal, the ways in which it is mined, and the multitude of uses which have been found for it.

Dr. Speare points out the advantages of coal mining as a vocation. Miners are the "aristocrats of American laborers." If the young man is especially able and ambitious he will find that coal mining engineering is an attractive, uncrowded profession of unusual opportunities. The Bituminous Coal Institute offers to interested educators a consulting service on work opportunities in the coal industry.

Coal is a mineral that has been formed in the earth by the decaying of plants, trees, ferns and other vegetation of several hundred million years ago.

The kind of coal found in the earth today varies with the greatness of pressure and intensity of heat acting upon the peat of the past ages. The peat was transformed first into lignite which in turn was changed into various grades of bituminous coal (soft coal). If the pressure and heat continued to increase, the bituminous coal became anthracite (hard coal) and later graphite, which is hard carbon too compact to burn. Under the most extreme pressure and heat, diamonds are formed out of pure carbon.

YOUNG MEN in training for mining careers (after they have passed their 18th year) working in the Maintenance Shop of the Mercer County Vocational School, Bluefield, W. Va.

These layers of "buried sunshine" often found in the earth one above the other are called *seams of coal.* What is believed to be the world's largest seam, 400 feet thick, exists in China and two seams in Wyoming are 90 or more feet thick. Other coal seams exist in the United States that are 40 or 50 feet thick, but the average thickness of the seams from which bituminous coal comes in our country is 5.4 feet. A few seams 18 inches in thickness containing valuable coal are mined. The bulk of bituminous coal mined in the United States is taken out of seams from 3 to 10 feet thick. The average thickness of the seams from which coal is produced in Great Britain is 4 feet.

The Greeks referred to coal in 300 B.C., and we know that England used 'cole' by 1300 A.D. Five hundred years before Columbus discovered America, the Hopi Indians in what later became Navajo County, Arizona, used lignite to burn pottery. The first written references to coal in America are found in the accounts of Joliet's expedition of 1673-4 to the Mississippi River. Coal was discovered on the James River in 1701. At first, it was used by local smiths; by 1745, it had wider distribution.

Bituminous coal was produced in western Pennsylvania soon after production was started in Virginia, and in 1788 it was produced in a third colony—Maryland. Most of the coal used in the northern colonies prior to the American Revolution was imported from England. Wood was the prevailing fuel in our country until about 1840.

Anthracite coal, mined in Pennsylvania, and marketed in the nearby states along the Eastern seaboard, is used for house-heating purposes, though small quantities of the finer sizes are employed in industry. The anthracite field is almost wholly confined to a small segment of northeastern Pennsylvania comprising about 480 square miles. In this small area there existed originally an estimated 21 billion tons; now about 15 billion tons remain. Geologically, anthracite was formed in the earth under greater pressure, and this accounts for its hardness. Because of its low amount of gaseous matter, anthracite is impractical for use in making by-products. It is also more difficult to start burning than bituminous, but once started the fire holds well.

There are two general methods of extracting coal from the earth. These are governed by the nature of the terrain, the thickness of the seam or coal-vein, and its proximity to the surface of the earth. Underground mines are classified as shaft,

slope, or drift. A shaft mine requires a vertical cut from the surface to get to the coal. When men have to reach the working area by means of an elevator, they are in a *shaft* mine. A *slope* mine or *drift* mine is reached by side openings leading into the main passageway having an upward or downward slope. If it were possible to lift off the top of any large mine and look in on this underground city, one would see what looks like main streets and side streets enclosing "rooms" from which miners have extracted the coal from the original seams.

The second general method of extracting coal is through *strip* or *open cut* or surface mining. This method is useful only when the coal seam runs reasonably close to the top of the ground. Here the top-dirt, called *overburden*, is removed by huge shovels, some of them with a capacity of as much as 35 cubic yards per lift—a shovel that can remove as much as 40 tons at a single bite. Now a "bulldozer" or rotary brush scrapes off the loose remaining dirt, and for the first time in millions of years real coal greets the sunshine. A shovel, able to pick up 8 tons at one bite, then lifts the coal to trucks which carry it to the tipple where, as in the case of that produced from underground mines, it is processed. *In 20 states* some open cut coal mining goes on today, and about 20 per cent of all bituminous coal produced comes from strip mines.

Coal mining has reached a higher stage of efficiency in the United States than in any other country. This is due to the fact that during the past two decades many millions of dollars have been spent by operating companies to mechanize the major mining operations, so that what was formerly laborious work done by hand is now carried on largely by electrical machinery, supervised by skilled workmen. The coal miner in the United States produces almost 5 times as much per day as does the English coal miner.

Most of us think little about the black, earthy substance called coal because, next to the dirt under our feet, there is more of this mineral in the ground of these United States than of any other mineral substance. But what an amazing thing bituminous coal really is! Through it we are able to capture the warmth and light that fell on ancient forests hundreds of millions of years ago.

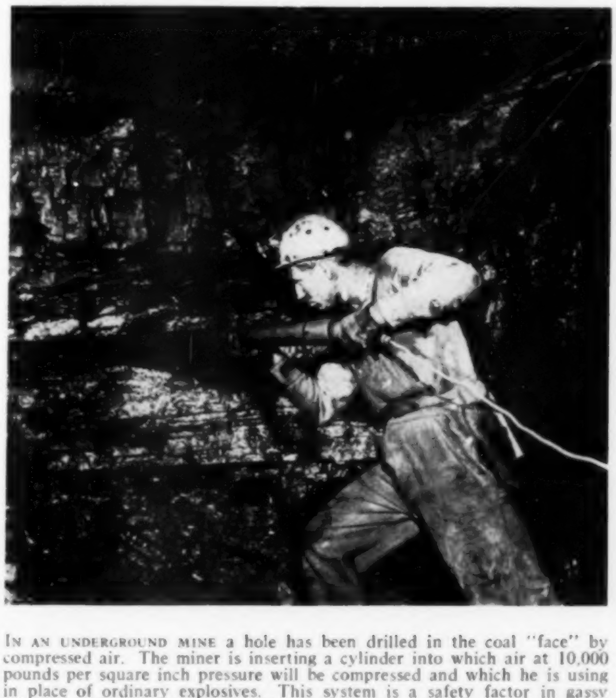
It has been said that there is no substitute for coal. This is peculiarly true for such basic industries as steel manufacture, which is 100 per cent dependent on coal for carbon in the form of coke. And without steel for construction purposes our industrial economy would be impossible. Gas and electricity, largely generated by coal, light our homes and streets and cook millions of our meals daily.

Bituminous coal is three fuels in one: petroleum, natural gas, and carbon. The gases and vapors from the coking of coal, in the hands of the chemical engineer, have become a kind of Aladdin's Lamp from which near-miracles appear. From it we obtain, not only much of our manufactured gas and our fixed carbon and most of our coke, but out of bituminous coal will come great quantities of synthetic petroleum for the future. When this nation's oil, limited at best, becomes exhausted, there looms from the reserves of this coal (which even at the present rate of consumption geologists tell us is enough to last for centuries) a possible source of synthetic gasoline. Synthetic liquid fuels made from coal have been produced in Germany for a good while. One process is known as hydrogenation. A different method of commercial promise in the United States would produce synthetic oil by first gasifying coal and then converting that gaseous mixture into liquid molecules such as comprise gasoline and fuel oil.

The bituminous industry represents an investment of over 4 billion dollars. It ranks among the ten highest industries in the United States in furnishing employment. Its close association with American railroads is evidenced by the fact that coal furnishes the railroads with 1/7 of their freight revenue and 1/4 of their total freight tonnage. More than 25,000 coal-burning locomotives were in daily use on the railroads of the United States in 1949.

The nation would be virtually paralyzed if the supply of bituminous coal were cut off, because of its widespread use. More than half of our electricity is generated by power derived from bituminous coal. Our coke ovens and the entire steel industry would shut down. Fifty per cent of the traffic on railroads would stop. Cement mills depend on bituminous coal for 69 per cent of their fuel. Industry in general gets one-half of its fuel supply from bituminous coal mines. Bituminous predominates as a household as well as an industrial fuel. It is burned under every imaginable condition,

(Continued on Page 28)



IN AN UNDERGROUND MINE a hole has been drilled in the coal "face" by compressed air. The miner is inserting a cylinder into which air at 10,000 pounds per square inch pressure will be compressed and which he is using in place of ordinary explosives. This system is a safety factor in gassy mines, and its gentle breaking effect on coal assures a larger range of coal grades or sizes when the coal is "knocked down."

Food Flavors

• By David E. Lakritz
CHIEF CHEMIST, FLORASYNTH LABORATORIES, INC., MANUFACTURING CHEMISTS, NEW YORK, N. Y.

Natural and artificial flavors are obtained from many sources. They must receive careful treatment. Much know-how is involved in selecting the right flavor form to use in any particular food product. Years of training and experience are necessary to make a worker an expert in this highly specialized field.

Here is good background information for the food technologist.

FLAVORS are substances imparting to food a specific or delicate quality affecting the senses of taste and smell. They are valuable adjuncts to foods, making them appealing to consumers. Although the simple tastes, such as sweetness, sourness, bitterness and saltiness are considered flavors, in this article we shall confine ourselves to that phase of flavoring affecting a combination of both the sense of taste and smell, the so-called aromatic taste.

That acceptable flavor plays a significant and major role in making foods palatable is readily apparent. It can easily be illustrated for each major food category: proteins, fats, and sugars. For instance, we know that proteins consist of amino acids, but a mixture of amino acids equivalent in food value to a given amount of protein is wholly unpalatable and actually nauseating. Fats like butter when pure and wholesome are palatable to most people, but some of the constituent acids, namely butyric, caproic, caprylic and capric acids, have markedly unpleasant odors. Sugars and starches are necessary to supply fuel for the body, but we have all tasted products that are too sweet and unpalatable if left unflavored. Starch can be so devoid of taste or flavor as to be distasteful.

Flavors are essentially an American specialty. Although they are used a great deal in foreign countries, they are not used to nearly as great an extent as in the United States. This is probably due to the tremendous progress made in this country in the development of the numerous branches of the processed food industry.

For all practical purposes, we can say that there are two major groups of flavors—natural flavors and synthetic flavors. All flavors fall into one of these groups, or are a combination of both. Natural flavors can be subdivided into:

(a) **Flavors of plant origin** comprising fruits, spices and herbs derived from fruits, buds, seeds, leaves, flowers, stems, bark, wood and roots of various plants.

(b) **Prepared flavors** of plant origin consisting of materials prepared or separated from naturally occuring sources; examples, essential oils, concentrated fruit flavors, and flavor extracts such as vanilla.

(c) **Isolates.** These are organic flavoring substances which are isolated from naturally occuring flavoring materials, particularly from the essential oils. Among the principal representatives of this group are anethol from anise oil, menthol from peppermint oil, citral from lemongrass oil, eugenol from clove oil, safrol from sassafras and Japanese camphor oil, etc.

Synthetic Flavors are comprised of:—

(a) **Semi-Synthetics.** These are flavoring substances prepared by synthetic methods, but using isolates like the aforementioned group as the starting material. Vanillin manufactured from eugenol is a typical example.

(b) **Synthetics**—these are made by synthetic methods; that is, use is made of simple organic compounds which are chemically identical with certain natural flavoring substances. Methyl salicylate, made by esterification of salicylic acid and methyl alcohol, is chemically identical with natural wintergreen oil.

(c) **Other synthetic flavoring compounds,** generally of vast flavoring power, which do not occur to any significant extent in natural flavoring materials. Among these are many esters, some aldehydes and ketones, and many lactones; such as: undecalactone having a peach aroma and flavor, but not found in peaches or other natural materials; nonyl lactone having a pronounced flavor of cocoanut but, to my knowledge, not found in nature.

Flavors are used in several different forms, such as alcoholic extracts, non-alcoholic flavors, emulsions, and

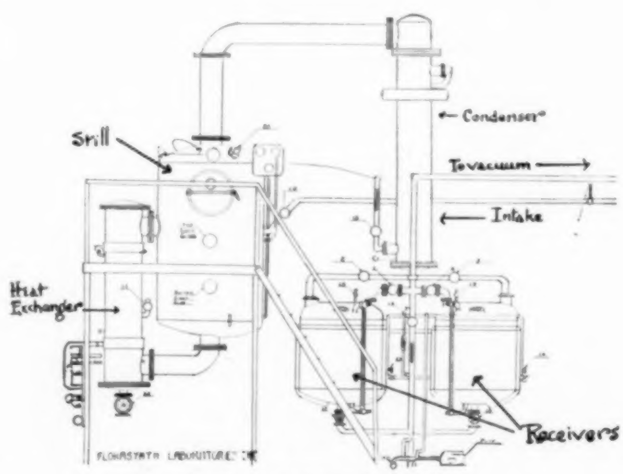


FIG. 1. A modern vacuum still.

powdered flavors, in practically every variety of food and beverage. The type and form of flavor selected by each food manufacturer varies with the particular food product for which it is used. This selection is sometimes based on a preconceived notion. For instance, a baker or confectioner may insist on using an alcoholic flavoring extract, even though the high temperature to which the food is subjected in processing would make the use of the less volatile non-alcoholic flavors desirable. However, in the majority of cases, the flavor manufacturer advises and helps the food processer to select the type and form of flavor best suited to his particular product. The accompanying table is a short list of finished food products and beverages, showing the different forms of flavors generally used for each.

FOOD FLAVORS

Foods and Beverages	Flavors Generally Used				
	Alcoholic Extracts	Non-alcoholic Flavors Water Soluble	Non-alcoholic Flavors Oil Soluble	Emulsions	Powdered Flavors
Animal Foods		x			x
Alcoholic Beverages	x	x			
Baby Foods		x		x	x
Baked Products	x	x	x	x	x
Carbonated Beverages	x	x		x	
Canned Foods		x		x	x
Catsup		x		x	x
Chocolate	x	x	x		x
Chewing Gum		x	x		
Confectionery	x	x	x	x	x
Cough Drops	x	x	x		
Doughnuts	x	x	x	x	x
Fountain Syrups	x	x		x	
Gelatine Desserts	x				x
Gravies		x		x	x
Ice Cream and Ices	x	x		x	x
Jams and Jellies	x	x		x	
Mayonnaise			x	x	x
Meat Products			x	x	x
Medicinal Preparations	x	x	x	x	
Mustard (Prepared)		x	x	x	x
Milk Shakes	x	x		x	x
Oleomargarine			x		
Popcorn		x	x	x	
Preserves	x	x		x	
Puddings	x				x
Pancake Mixes & Syrups	x	x			x
Pickles		x		x	x
Soups		x		x	x
Sauces		x	x	x	x
Salad Dressings		x	x	x	x
Sherbets	x	x		x	x
Table Syrups	x	x			
Vitamin Products	x	x	x	x	
Vegetable Oils			x		
Vinegars	x	x			
Wines	x	x			
Whiskies	x	x			

As mentioned above, flavors are manufactured in many different forms such as:—

(1) **Alcoholic Extracts.**
   (a) Made with alcohol or mixtures of alcohol and water to extract the aromatic principles of a plant or fruit; such as vanilla extract from the vanilla bean; raspberry and strawberry extracts made from the fresh, frozen or dried fruit.
   (b) Made by dissolving essential oils in alcohol or alcohol and water; such as lemon, bitter almond, and other extracts.

(2) **Non-alcoholic, water miscible flavors,** made with such solvents as propylene glycol, glycerine, sugars and water.

(3) **Non-alcoholic, oil soluble flavors** made with vegetable oils as solvents.

(4) **Emulsion type flavors** made with vegetable gums, such as tragacanth, acacia, karaya, locust bean, or synthetic gums such as cellulose esters, polyhydroxy alcohol esters of fatty acids, and others.

(5) **Powdered flavors** made by mixing spices, extractives, essential oils, aromatic chemicals, or mixtures of these, with sugars, starches, or salt as the vehicle.

These forms are found to be more practical than the use of the straight essential oils or aromatic chemicals. Aromatic chemicals and flavoring oils are at best only very slightly soluble in water and most food products, and may not be evenly distributed if introduced directly. For full effectiveness of flavoring there must be a uniform distribution throughout the product being flavored. In many cases, the undiluted materials are too concentrated for foods requiring small amounts of flavor, so that one of the above forms is better suited to the need of the food manufacturer.

Natural extracts, alcoholic and non-alcoholic, are manufactured by many different methods or combinations of methods. The old method of maceration and/or percolation is still used but, of course, with newer and vastly improved machinery, resulting in much superior extracts. Extracts of high concentration are manufactured in various ways such as percolation and/or evaporation, or distillation at atmospheric pressure or under vacuum. The most advantageous method is vacuum distillation. Here the more volatile elements of the flavor are recovered, and the heat to which the material is subjected can be maintained at a minimum insuring against any cooked flavor in the concentrate. This production of concentrates with little loss of quality or quantity of flavor is due chiefly to the modern, improved equipment such as we use at the present time. (Fig. 1.)

Essential oils are removed from the plants by such methods as *steam distillation*, as in the case of clove, nutmeg, peppermint, etc.; *expression*—lemon oil, orange oil, and *extraction* with volatile solvents and subsequent removal of the solvent by evaporation or distillation.

Various terpeneless and concentrated oils are also used. These are prepared by the fractional distillation in vacuum of the essential oils.

Emulsion type flavors are made by mixing an essential oil with a vegetable gum. Then water, or water mixed with a little glycerine or propylene glycol is slowly added and the whole constantly stirred. To render emulsions more stable, they are run through a homogenizer or a colloidal mill.

Powdered flavors are made by simply mixing the ingredients in dry powder mixers. All other flavors are made by simply dissolving the ingredients, such as essential oils and/or aromatics, in the suitable solvents.

Flavor manufacturing is a highly specialized field. Years of training and experience are required to become an expert in the field. The flavoring chemist of today blends scientific knowledge with an artistic sense to flavor successfully a great assortment of foods, thereby bringing enjoyment and nourishment to the table of the consumer. ●

NEW BOOKS

Giant Brains

• *By* EDMUND C. BERKELEY. New York: John Wiley & Sons, Inc. 1949. Pp. xvi + 270. $4.00.

One of the outstanding achievements of recent years is the development of machines that "think," that solve in a few minutes problems that normally would require a very long time and many human workers. These mechanical brains have already proved their usefulness in business and in government as well as in science and research, but the study of their possibilities and of their value to society has only just begun.

Understanding their construction and operation is not beyond the layman when they are so clearly explained as they are in "Giant Brains." There is material too for the trained mathematician, but each reader can select the portions of the book fitted to his needs and interests. Mr. Berkeley knows automatic computers and how they work, and he writes about them in a pleasant, clearly understandable style.

H. C. M.

Handbook of Chemistry

• *By* NORBERT A. LANGE. Sandusky, Ohio: Handbook Publishers, Inc. 1949. Pp. xvi + 1920. $7.00.

The handsome seventh edition of Lange's Handbook of Chemistry needs little comment from the reviewer other than to state that this new edition is now available and that it is more extensive and better than ever. A dozen completely new tables have been added, and perhaps twice that number extended or wholly rewritten. The very complete index is a notable feature.

Although a handbook of chemistry, this desk and laboratory reference book with its wealth of information, tables, and formulas will be of aid to physicists, engineers, pharmacists, manufacturers, students and others working in science or science-related fields.

H. C. M.

Physics, The Story of Energy

• *By* H. EMMETT BROWN and EDWARD C. SCHWACHTGEN. Boston: D. C. Heath & Co. 1949. Pp. xi + 593. $3.20.

In its sequence of presentation this new textbook does not follow the conventional order. It opens with a consideration of sound energy. Then follow in order five other units: light energy, energy and the work of the world, electrical energy, energy and motion, and finally energy and molecules.

Written by the head of a science department in a teachers college and by a teacher with trade school and high school experience, the choice of material is excellent and well suited to capable high school classes. The mathematical treatment is especially good. The book is well made and attractively bound. It contains 528 illustrations, mostly line drawings, and 4 color plates. There are concise chapter summaries, and a plentiful supply of questions and problems, "things to do," and exercises for advanced study.

A. K.

Learning Electricity and Electronics Experimentally

• *By* LEONARD R. CROW. Vincennes, Indiana: Universal Scientific Company, Inc. 1949. Pp. xi + 523. $5.50 (List).

An educational specialist in the development of electrical instruction felt the need for a textbook written in simple language and using the project approach to the study of magnetic and electrical phenomena. This lithoprinted book is the result. It contains some 134 experiments and enough theory to make them intelligible. The exercises are plainly described and explained, the illustrations clear, and the necessary apparatus comparatively inexpensive. Only simple arithmetical calculations are required.

The high school teacher may care to use a number of the experiments as supplementary exercises. Interested students will find much of the book suited to self instruction.

A. K.

Survey of Biological Progress, Volume I

• *By* GEORGE S. AVERY, Editor. New York, N. Y.: Academic Press, Inc. 1949. Pp. 396. $6.80.

This valuable book is intended by the editors "to serve the biologist who wishes to be well informed in fields marginal to or beyond his own special sphere of interests—fields he would have neither the time nor opportunity to follow systematically in the original literature. By thus providing a medium for integrated presentation of facts and thoughts from all fields of biology, the Survey aims to offset in a certain measure the isolating effect of rapidly increasing specialization."

Most of the articles in this first survey volume accomplish this aim very well. Some authors, notably Dr. Philip White in his article, "Growth Hormones and Tissue Growth in Plants," have reviewed and evaluated a great mass of literature for the reader without citing a large number of references. Others, such as Dr. Bentley Glass in "The Genes and Gene Action," Dr. D. P. Costello in "Growth and Development," and Dr. W. A. Frazier in "Newer Methods in the Rapid Development of Disease-resistant Vegetables" organize a great amount of material and cite a large number of references for the reader to use if he wishes.

Helena Miller
Department of Biological Sciences
Duquesne University

The Splendour That Was Egypt

• *By* Margaret A. Murray. New York: Philosophical Library. 1949. Pp. xxiii + 354. $10.00.

This book is a "general survey of Egyptian culture and civilisation" written for the interested layman as well as for the student. It will bring useful information to teachers in almost every department of high school or college. It contains material not easily located elsewhere. One of the book's most attractive features is the collection of nearly 100 illustrative plates, including a few in color, and the 24 line drawings scattered throughout the text.

A 10-page section deals with prehistory. Then come longer sections discussing history, social conditions, religion, art and science, and language and literature. The final brief section is an appreciation of Mr. Flinders Petrie with whom the author was associated at University College, London, and "who out of the hobby of antiquarianism created the science of archaeology." Some readers will be disappointed to find only a sparse five pages devoted to science. But this should not discourage teachers of science from learning more about the ancient country in which we find the earliest beginnings of material culture, the sciences, and the imponderables of law, government and religion.

H. C. M.

COAL---A Vital Factor

(Continued from Page 23)

from the open grate to the automatic coal-burning device. It is consumed in every size, from powder to large lumps. Modern stokers feed it automatically into furnaces.

The wizardry of modern chemistry has opened up in recent years astonishingly new vistas of usefulness from the black lumps of coal. There are about 200,000 byproducts derived from bituminous. Among these are the sulpha drugs that save lives; the anesthetics, the barbiturates, and the aspirin that have given relief from human pains; the moth-flakes and disinfectants; the flavoring extracts and baking sodas; the train-loads of fertilizers which have helped add billions of bushels of luscious crops to our tables. Some time before the outbreak of World War II we were already learning of new byproducts to rival the nylon, the sulphas, the fabulous drugs, dyes, cosmetics, perfumes, the phonograph records, the synthetic rubbers, and the amazing array of plastics that have their origin in black, "magical," bituminous coal.

In the field of industrial chemistry the prospective byproducts of coal are so vast as to be almost beyond the grasp of the average mind. Paint that not only will not peel or burn, but will actually give off carbon dioxide as a fire extinguisher; enamel that won't scratch; dyes that won't run or fade; wood that won't warp or crack or mar; textiles of amazing varieties of colors and durability; plastic shoes made of any color in the spectrum that will be light, attractive, durable, and waterproof; woolens that won't shrink; stockings that won't run. In all these industries, built on chemical byproducts of coal, there are professional chances for the school-graduate of tomorrow.

Great opportunities are in store for young men, in particular graduates of high schools, if they choose coal mining engineering as a career. Coal mining is by very nature a young man's field. I know of no other industry where the application of one's efforts are subject to more variation, and where the individual's inventiveness and ingenuity are challenged to a greater degree. Where, for example, could one find more interesting, broader, and more diversified application of electricity in all its phases than in coal mining? Similar statements can be made regarding the use of legal training, industrial relations, accounting, etc. The coal miner is among the highest paid of all men employed in the 160 leading American industries on which the U. S. Department of Labor Statistics gathers information today. The coal miner, when he is allowed to work without stoppages imposed by his union, is, from a monetary point of view, the aristocrat of American laborers. The safety record today in coal mining

is better than it has been ever since the U. S. Bureau of Mines began collecting information on this matter in 1910. The coal mining engineer may expect comparably, therefore, to receive a higher monetary reward than a great many other types of technical graduates who plan to take up other kinds of scientific careers. The ranks of some lines of engineering are being overcrowded. That is not true of coal mining engineering.

In the high schools, opportunity should be given the students to prepare themselves to go directly to the mines for employment, or to go to college to take engineering. In either case, there is a responsibility on parents and teachers to guide the student along the path he is best fitted to follow. If he has a mechanical bent and is not anxious to take college work, by all means give him a good foundation in high school to prepare him for employment when he finishes his course. If he has the aptitude for college, see that he studies the courses required for admission.

If a student gets to college and studies mining engineering, he is in a fortunate position. At the conclusion of his course, he may go into mining or some other branch of engineering. The advantage of the mining course is that it serves as an introduction to engineering. It gives the student some electrical, mechanical, metallurgical, civil, and geological engineering. In fact, it may be regarded as a broad foundation in general engineering. Therefore, the student who is not entirely sure about the kind of engineering he wishes to follow may take mining in the knowledge that he is getting a good start, regardless of later decisions. There are 33 colleges and universities in the United States offering courses in mining engineering leading to a degree. This seems to be an ample number, and they are located throughout the country so that excessive travel is not required.

Scholarships are available in many of the departments of mining engineering. There are not enough, but a properly qualified student should not hesitate to apply for admission because of lack of funds. A good record in high school is almost certain to win some sort of financial help in college. Some coal companies provide scholarships for the sons of employees. One such company is advertising now among its families that it is prepared to offer a student a scholarship of $500 per year with employment during the summer. Usually, that amount and the summer's earnings take care of the expenses of the college year. The company, in its announcement, states that after graduation, the student will be entirely free to take employment wherever he may desire.

For all these reasons it behooves educators to give this subject their most careful consideration, and to pass on information about opportunities in the coal industry to the young men under them.

The profession of coal mining engineering should be drawing more capable young men than it is today. Fewer workers are now needed in each mine, but they must be better men. Mechanization calls for experts. Opportunities in the field of coal production are many, and more desirable than most people think. But opportunities are not confined to production. Modern distribution also calls for experts in management and sales. Competition is keen within the industry, and keen as between coal and other fuels. Good men are needed, all along the line, and many boys can be well served if educators and mine operators work together in making this line of endeavor more attractive to more youngsters who are in search of the sign-board that says—"This Way to Security!" The Educational Department of the Bituminous Coal Institute will be glad to give educators who are interested, further information about the professional opportunities open to young men-graduates, eighteen years of age and over, in this basic industry. ●

★ ★ ★ ★ ★

"By the time boys and girls have reached teen age they have learned to take much of the everyday world for granted. This is a common technique in adjusting to a culture as complex as ours. As a result, we are naive in assuming that young people are interested in the commonplace things around them: the electric light, the telephone, the seasons, the purification of water, or heating a house. They rarely are, unless some personal problem is involved."

—*Science for the Teen-ager*
HERBERT S. ZIM

Anhydrous Ammonia

(Continued from Page 19)

anhydrous ammonia has been found to be equal to ammonium nitrate for side dressing.

The Response of Crops

A large number of experiments comparing anhydrous ammonia to ammonium nitrate have been conducted with corn, cotton, and oats. When 32 pounds of nitrogen was applied four inches deep to cotton before planting, anhydrous ammonia increased the yield 354 pounds of seed cotton as compared to 277 pounds for ammonium nitrate, the superiority of anhydrous ammonia being due to less leaching of nitrogen. Anhydrous ammonia produced an additional 38 pounds of seed cotton when applied six inches deep. Both sources increased the yield about 300 pounds of seed cotton when used as a side dressing. When applied to corn the increase was 16.2 bushels for anhydrous ammonia, and 14.3 bushels for ammonium nitrate.

When solid sources of nitrogen are used as a side dressing, they may be applied on the surface while the crops are young because there is usually sufficient rain to carry them into the soil. When they are applied later and dry weather follows, surface applied fertilizers may have little value. Under such conditions anhydrous ammonia applied five inches deep has proved much superior to ammonium nitrate applied on the surface.

Anhydrous ammonia has been a good source of nitrogen for oats when applied at the right time. It is applied before oats are planted for forage. On strongly acid soils the ammonia may be applied before planting to late-planted oats for grain. On most soils anhydrous ammonia should be applied in February to oats for grain.

Oats use ammonium nitrogen well while they are young; however, fall planted oats require nitrate nitrogen in the spring. Anhydrous ammonia should be used as a top dressing for oats on strongly acid soils by the first of February.

Transporting 4500 lbs. of Anhydrous Ammonia which contains as much nitrogen as 11,000 lbs. of ammonium nitrate or 23,000 lbs. of sodium nitrate.

On the average, two and one-half pounds of nitrogen costing 20 to 50 cents make one bushel of corn, 30 pounds of seed cotton, and two bushels of oats.

Anhydrous ammonia has also proved to be a good source of nitrogen for sweet potatoes, sorghum, tung trees, tomatoes, beans, and cabbage.

The Outlook

Prior to 100 years ago farmers depended upon organic materials primarily for such nitrogen as was available for crops. In the South, at least, fertilizers are now supplying a great deal of the nitrogen for increased yields. Most of our research information on fertilizers has been obtained during the last 25 years. Only a few farmers yet realize the full potentialities of fertilizers. The production of 100 bushels of corn per acre would not make the headlines in most County papers in this area. It appears that it is possible to double our average corn yield. Considerable increase in the yields of other crops may be anticipated.

Record yields of most crops have been made in recent years. The potential productivity of our soils for purposes for which they are suited is increasing rather than decreasing. Idle land suggests that our economy is not yet ready to pay the cost of putting it into production. We have large areas of undeveloped bottom lands. We have the know-how to produce food and clothing for fifty per cent more people than we now have. If we should have a fifty per cent increase in our population, our know-how will have advanced until possible shortages of food and clothing will still be in the unforeseeable future. ●

Farming in Japan

(Continued from Page 16)

areas, even soil surveys are being made so that these soils may be used to their best advantage for maximum crop production and minimum soil losses.

Effects of Atomic Bombing on Crop Yields

Probably most of the increased crop yields reported by Japanese farmers after the atomic bombings in Hiroshima and Nagasaki can be attributed to the beneficial effects of burned soil and especially to ash accumulated from organic matter and burned buildings, rather than to the effects of radio-activity *per se*. Large amounts of ash were added to the soil, and, in many cases, land was cultivated which formerly was occupied by buildings. Japanese scientists have estimated that ash from one ordinary house is equivalent to adding approximately 3 short tons of lime (CaO) and 0.8 short tons of potash (K_2O) to the soil. Removal of trees and buildings by the bomb increased the sunlight in many areas. Soil temperatures are thus raised and the additional sunlight had a favorable effect on plant growth. The bomb also partially sterilized the soil to a depth of 4 to 6 inches. This partial sterilization may have produced a beneficial response on plant growth in releasing nutrients contained in the bodies of soil microorganisms to plant roots. ●

Keeping Up With Chemistry

(Continued from Page 4)

then the policy of publishing ten-year patent-number indexes was adopted.

What the abstracts accomplish in bringing the scattered literature of chemistry together in one available place and language, the indexes accomplish in bringing the concentrated information of the abstracts into accessible form for use at any time. The subject and formula indexes are based on the whole abstracts and at times even on the complete papers, not on their titles alone. While the average is five subject index entries per abstract, it is not uncommon for an abstract to have a hundred subject entries and the record is 1060 such entries for a single abstract.

There are a number of lesser or auxiliary operations which will only be mentioned here. One is the publication of titles of new books of chemical interest. Then there is the publication at five-year intervals of a List of Periodicals Abstracted with a key to library files (the last list covers 209 pages). A photocopying service is maintained which bridges the gap between abstracts and original papers. A sort of clearing house for chemical nomenclature information is maintained. *Chemical Abstracts*' 109-page booklet entitled "The Naming and Indexing of Chemical Compounds by *Chemical Abstracts*" is said to be the most comprehensive discussion of modern chemical nomenclature in print.

This brief story of the production and function of *Chemical Abstracts* would not be complete without appreciative mention of the large amount of unselfish help provided by the many abstractors and the section editors. They do an enormous amount of work for little or no pay. Six workers have been associated with *Chemical Abstracts* since its beginning in 1907. The group which has been helping in this work over thirty years is large. Chemists are willing to help in such an undertaking because *Chemical Abstracts* is useful. ●

★ ★ ★ ★ ★

"No nation in the world equals America in her faith in education. It is a national trait to assume the more education the better. Yet it is a curious fact that, while we display such a widespread trust in education, as a people we have so little respect for scholarship. We Americans spend the wealth of an empire on formal education, almost from the cradle to the grave, but we rarely look under the cover to examine whether or not we are buying genuine excellence with our money."

—Harold W. Dodds, *Pres., Princeton University*
The Liberal Arts—A Challenge to Communism
Assn. of American Colleges Bulletin, October '49

Teaching Heredity

(Continued from Page 2)

One of the objectives is to have the students learn the laws of heredity. They may be stated as follows:

Law 1. When two individuals, plants or animals, of pure stocks and possessing contrasting characters are crossed, all of the individuals, or hybrids, of the next generation will show only one of the two characters, the dominant one. The character of the other parent not shown in the hybrid is known as the recessive.

Law 2. When the hybrids of the first generation are inbred, the offspring of the second generation will show segregation in the ratio of three dominants to one recessive. One of the three dominants is pure stock; the other two are hybrids.

It is most important to give students a good understanding of these laws. Lantern slides and book illustrations accompanied by class discussion and reading will aid much in learning the laws.

A few simple experiments performed by the pupils will add to their interest and understanding of the subject. The following simple experiments are suggested:

1) The fruit fly, *Drosophila*, may be obtained and readily cultured in the laboratory. The following experiments can be successfully performed:

(1) The gray body type x the black body type.
  (a) The first generation hybrid will all be of gray body. Hence, as is obvious, the first law can be readily demonstrated.
  (b) By inbreeding this hybrid generation, the law of segregation can be illustrated.

(2) The fly with a gray body and brown eyes may be bred to the fly with a black body and with sepia eyes to demonstrate the behavior of a typical dihybrid.

The genes of the characters above are borne in the ordinary chromosomes, unlike the genes for red and white eyes which are sex-linked. A cross involving such sex-linked characters is interesting, but should not, as is well known, be made to illustrate the laws of Mendel.

2) Pure stock black and albinic mice may be used to illustrate the laws of Mendel.

3) Seeds of *Datura* of the purple cotyledon and the green cotyledon types may be planted. Seeds also of the cross between the two and of the first generation hybrid may be obtained and used similarly to demonstrate the laws of Mendel.

4) Corn, heterozygous for albinism, may be obtained and planted. This corn will, of course, show a typical segregation of three dominants to one recessive.

I wish to emphasize the fact that these experiments are undoubtedly at the high school level. Some of the high school textbooks, however, make the subject difficult and sometimes confusing.

Another objective in teaching heredity is to give the student an elementary knowledge of the physical basis

of inheritance, namely the gene. I think the chromosomes of plant and animal cells should be demonstrated. Of course, the gene is invisible.

To give the student the knowledge that the laws of heredity apply also to man with respect to his physical, physiological, and mental traits is another objective in teaching the subject. This information is ordinarily given in the high school textbook. Simple facts in regard to human heredity are interesting and readily presented to students even of high school age. Among these are the inheritance of such physical traits as hair and eye color, polydactyly, brachydactyly, syndactyly; such mental traits as feeble-mindedness, literary, musical, and artistic ability, and so on.

It is interesting and important to discuss the inheritance of physiological traits like allergy, about which so much is becoming known today. It can be readily understood that such a trait as allergy, if hereditary, must be treated quite differently from a germ disease. Perhaps we have made no more progress in learning its causes because most of the members of the medical profession have been unaware of its hereditary nature. Frequently, no doubt, members of this profession lacking a knowledge of the hereditary nature of disease, make errors in diagnosis and treatment of certain ailments, such as abnormal blood pressure, which is also hereditary. Perhaps the best illustration of the misunderstanding of the public in regard to a hereditary trait is that of baldness. Some seem to think that the hair once gone can be restored. Since, however, in baldness, the hair follicles are destroyed, there can be no hope of obtaining a normal growth of hair again.

The student should also learn that acquired characters are not inherited. Reference in this connection may be made to the life and work of Lamarck and of Weismann. Numerous illustrations may be given of supposed cases of the inheritance of acquired characters.

It is important to implant in the mind of the student the idea of race improvement and the best means by which it can be accomplished, such as segregation of defectives and education of the normals for careful selection of marriage partners. In presenting this phase of the subject, commonly known as eugenics, it should be pointed out that only those eugenic measures which are justifiable can be sanctioned by the good citizen. The student should also be made conscious of the fact that it may be a worthy objective to improve not only the physical and the mental, but also the spiritual qualities of the race. ●

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"I should like to say to you young scientists and students that it is my sincere wish and hope that the dust of things may never dry up the wells of your spirit."

—*Ideas, Men and Things*

J. O. PERRINE

Plant Growth Hormones

(Continued from Page 8)

While at present a diligent search is being made for synthetic compounds built along similar lines to be used in agriculture, others are trying to understand the basic metabolism of the action of these substances. Attempts are also being made to find substances directing other processes in the plant. A wound hormone has been isolated which causes cell proliferation, some of the vitamins such as B_1 and nicotinic acid have been found to be essential for the growth of roots, and adenine has been recognized as a leaf-growth factor. Continued research in this direction will undoubtedly furnish a number of new substances which will contribute to our knowledge of plant metabolism and will also prove valuable in the practice of agriculture. ●

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Lecithin

(Continued from Page 12)

down on the descending side of the chamber. As the baskets move slowly around the circuit, oil is dissolved from the beans by a spray of solvent which collects at the bottom of the apparatus. Upon reaching the top of the ascending side the baskets are automatically inverted and the spent flakes dumped into a discharge hopper, whence they are fed into driers which are located outside and alongside the vaportight extraction chamber. After being dried to remove absorbed solvent the spent flakes are further processed for animal feed or for soybean flour for human consumption.

The oil and solvent solution, called "micella," is pumped from the bottom of the extractor through a series of evaporators which remove all traces of solvent. The phosphatides which are dissolved in the oil are next removed by adding to the oil a small amount of water. The phosphatides become hydrated causing them to precipitate out of the oil. The oil stream now containing the hydrated phosphatides is passed through high speed centrifuges which clarify the oil by separating the hydrated phosphatides from it. The oil leaves the centrifuge for further processing. The hydrated phosphatides from the centrifuge are collected and subsequently dried in a vacuum drier. After the removal of water the phosphatides become a viscous oily mass having an amber color and a consistency of thick molasses, and the material is ready to be filled into shipping containers.

When lecithin is hydrated to remove it from the oil, some oil is bound or trapped by the lecithin. No oil is added as such. The finished product will contain approximately 65 per cent phosphatides and 35 per cent soybean oil, and it is this product which is commercially known as lecithin. The moisture content of the finished lecithin will be 1 per cent or less. It will have practically no odor and only a mild taste.

To understand why the chocolate manufacturer uses lecithin we must understand some of the properties of lecithin particularly in relation to the process of making chocolate. Lecithin has surface active properties and for this reason it is considered a surface active agent, or wetting agent. Surface active agents modify the physical properties of a mixture when added in small quantities. Such agents usually are organic compounds whose molecules contain both an oil-soluble group and a water-soluble group. The lecithin molecule, for example, can be pictured thus:

$$\left.\begin{array}{l} CH_2OOCR \\ \;| \\ CHOOCR \end{array}\right\} \text{Oil-soluble part}$$

$$\left.\begin{array}{l} \;| \qquad\quad O \\ \;| \qquad\quad \| \\ CH_2\text{—}OPO\text{—}(CH_2)_2\text{—}N(CH_3)_3 \\ \qquad\quad | \qquad\qquad\quad | \\ \qquad\; OH \qquad\qquad OH \end{array}\right\} \text{Water-soluble part}$$

LECITHIN

One of the most common phenomena is the wetting of a solid by a liquid. This is involved in preparing a chocolate coating, for in its simplest form the coating consists of a mixture of ground cocoa beans (chocolate liquor), finely pulverized sugar, and cocoa butter. Sugar is very easily wetted by water, but not easily wetted by an oil or fat. In making chocolate, considerable energy must be applied to cause the cocoa butter to properly wet the sugar surfaces. If, however, we introduce a surface active agent such as lecithin, much less energy will be required. When lecithin is added to chocolate it reduces the interfacial tension between the cocoa butter and the sugar particles, and the sugar will be readily wetted by a lesser amount of the cocoa butter. Since only the actual surfaces between the sugar and the cocoa butter are involved, the amount of lecithin needed is very small, approximately 0.25 per cent. This amounts to about 4 oz. of lecithin per 100 lbs. of chocolate. This small quantity enables the chocolate manufacturer to produce a product that has better flow characteristics and more uniform texture, and in addition saves processing costs.

Large quantities of lecithin are used by the oleomargarine industry although the actual amount used in margarine is only from 0.10 to 0.25 per cent. It is an anti-spattering agent and prevents the milk solids from sticking when margarine is used for frying. Margarine is an emulsion of vegetable oil, milk solids, salt, and water. When it is heated, as in frying, water is driven off and the milk solids precipitate. Lecithin acts at the fat and water interface to prevent coalescence of the water. The evolution of water is gradual and in small droplets and spattering is prevented. It also wets the milk solids with oil causing them to remain freely movable without sticking.

The property of lecithin of modifying physical properties by adsorption at an interface is utilized in many processes and products. While a large portion of the lecithin produced is used in foodstuffs, a nearly equal portion is used in other industries. The paint industry is a large consumer of lecithin. It aids pigment dispersion, helps to control viscosity, and greatly reduces hard settling of pigments. Lecithin is used in printing inks as a wetting agent. In the processing of leather and furs for garments lecithin is used as an ingredient of fat liquors. Many textile products are treated with softening and finishing agents in which lecithin is used. The casting of clear plastic films is aided by small amounts of lecithin, which serves as a parting compound. In the molding of certain rubber and plastic articles lecithin is utilized as a mold release agent. Many cosmetic products, such as lipsticks, creams, permanent hair-wave creams, shampoos, etc., utilize lecithin in varying amounts.

One would suspect that any substance found universally in living tissues would possess special nutritional or medicinal properties. Much work has been done to assess the role of lecithin in life processes. It is beyond the scope of this article to discuss this interesting subject, except to state that it is generally recognized that lecithin plays an important role in the metabolism of fats. Clinical studies have shown the effectiveness of lecithin in the prevention of fatty livers and in the treatment of some cases of psoriasis. The utilization of Vitamin A and carotene is enhanced by lecithin. Already, quantities of lecithin are being utilized in human and animal nutrition. This field of use has been slow in developing but there are indications that it may eventually become the largest use. ●

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"What appears to be classical through the years may be nonsensical tomorrow. What appears to be iconoclastic today may be eternal truth tomorrow. Mother Nature is not a garrulous, kindly lady in lavender and old lace. She is a sphinx; she zealously guards her broad, basic truths, her elemental phenomena. She locks them in strong boxes. The jewels in her treasure chest are not presented on a silver platter. To find the keys, to unlock the chest, the scientist must have curiosity, determination, imagination and intelligence."

—*Ideas, Men and Things*

J. O. PERRINE

★ ★ ★ ★ ★

"The physical sciences offer us tangible goods; the biological sciences, tangible cures. The social sciences offer us better ways of organizing our lives."

PRESIDENT HARRY S. TRUMAN

Industry-Education

(Continued from Page 18)

other than booklets and leaflets are subject to the same evaluation as standard Packet items. An additional feature of the Packet Service is that each Packet contains an order blank so that teachers may write to the source for as many additional copies as they wish for pupil use.

Investigation has shown that the most common use of these teaching aids is in the average science classroom with its large heterogeneous group. Teachers build up classroom reference shelves of industrial pamphlets and booklets. Many keep sets of pamphlets, sufficient for an entire class, on subjects related to the topics being taught. The variety of Packet items thus serves a wide range of pupil interests. Pupils of above-average ability may be encouraged to read materials related to class topics and to report on new developments to the whole group. This provides an excellent opportunity for gifted pupils to expand their knowledge and, at the same time, bring this information in understandable form to other members of the class.

The Advisory Council has obtained grants in aid from certain industries to carry on research studies for the improvement of supplementary teaching materials. The first study involved the following: *(a)* obtaining information concerning how science teachers use literature from industry; *(b)* obtaining the judgments of teachers on the desirable characteristics of sponsored aids; *(c)* determining the most effective ways of incorporating sponsored materials into science teaching; and *(d)* encouraging teachers to explore and develop some potential uses of promise.

The information indicated was obtained through questionnaires designed by a research committee of the Advisory Council in cooperation with the Research Division of the National Education Association. A carefully worked out questionnaire was sent to the entire NSTA membership. A response of over 30 per cent returns was experienced. Teachers indicated that Packet materials have been found useful in the following ways: *(a)* information, teacher only; *(b)* library reference use; *(c)* classroom reference use; *(d)* bulletin board displays; *(e)* special pupil reports; *(f)* vocational guidance; *(g)* to supplement the text; *(h)* to motivate a unit; *(i)* in science club activities; *(j)* assigned pupil reading. Many suggestions for additional types of materials and for improvement of existing items resulted from the returns on this questionnaire. Further studies are projected to determine the most needed types of material upon which the production energies of industry may be focused. Additional funds have been made available from industries concerned.

In addition to the three national conferences on Industry-Science Teaching Relations mentioned earlier, a series of regional conferences are planned. The first of these was held at the Mellon Institute in Pittsburgh on September 30, 1949. More than 200 representatives of science teaching and the industries of the region attended this trial regional conference. From it came

leads which point to closer cooperation between industry and education in the region.

Bertha E. Slye, Director of NSTA Membership Service from 1946 through 1949, states that the busy science teacher must: (1) Keep informed on the many changes in contemporary living; (2) Keep a true perspective of educational problems in spite of the changes; (3) Read objectively and select with discrimination those items of interest to him and pertinent to his teaching; and (4) Streamline his classroom techniques to make effective use of the information. The Advisory Council on Industry-Science Teaching Relations plans to carry on and expand its present program to the end that all science teachers may be reasonably up to date in terms of these modern criteria. ●

Radioisotopes

(Continued from Page 11)

unique application of man-made radioisotopes and will be illustrated by radioactive iodine and gold. Radioisotopes are also being used as fixed sources by physically placing the material in the desired position. In this way a source material may be made to serve the same function as radium or x-ray machines.

The best example of selective localization in radioisotope therapy is that exhibited by iodine 131. Radioactive iodine has been used effectively in the diagnosis and treatment of diseases associated with overactive and rampant cells of the thyroid gland as portrayed in *Figure 9*. Because of the extreme eagerness of the thyroid tissue for iodine the physician is able to deliver large doses of radiation by means of iodine 131 to the diseased gland.

Radioactive iodine has been found to provide a simple yet effective method for treating patients with hyperthyroidism. This isotope is proving a particular boon to patients where surgery is not possible. Limited success in controlling cases of thyroid cancer has been observed, using radioiodine therapy.

The therapeutic values of other radioisotopes, such as gold 198 are also of considerable importance as a means of providing localized radiation. Radiogold prepared in the form of a colloid has provided a method for selectively placing a radioactive material into the lymphoid system of the body, through which cancer frequently spreads. *Figure 10* diagramatically pictures this application. Biological studies have shown that gold colloid experiences little turnover into adjacent body tissues, thereby eliminating for the most part irradiation of normal functioning cells and tissues. In the treatment of diseases of the lymphoid system, the radioactive gold (Au 198) may be introduced directly into the tumor site by local injection, or it may be administered intravenously into the patient where it is taken up primarily by the spleen and liver.

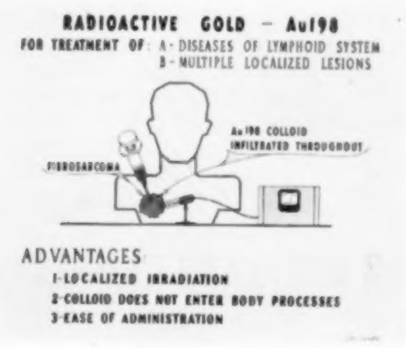

FIGURE 10.

The aforementioned are representative of only a few of the more interesting and significant applications of radioactive isotopes as agents for delivering ionizing radiations to diseased cells and tissue. As more clinical and animal data are accumulated and accurately evaluated definite conclusions regarding the relative therapeutic effectiveness of other radiomaterials may permit their use in the treatment of a greater number of the diseases besetting mankind.

Conclusion

Radioisotopes in the hands of the biologist, chemist, physicist, engineer, agriculturist, and physician, are opening a new era of investigative research. They are tools for gaining new knowledge and reevaluating old

concepts. Like prehistoric man who could not conceive a blast furnace when he opened a new era by first lighting a fire, we are unable to foresee the ultimate benefits which these scientific tools will have upon our lives and our world. ●

Counseling Students

(Continued from Page 21)

Occupational Information

Students who possess the essential qualifications for success in science and who undertake this training must be prepared to maintain the maximum degree of occupational flexibility in order to adapt themselves to changing circumstances. This means that they must secure the broadest possible scientific education as well as a specialized training in a particular field. In addition they must be informed concerning the various functional specializations *within* scientific fields: research, production, service and sales, purchasing, patent law, writing, editing, library work, administration, consulting work, governmental service, institutional service, and teaching. Because they falsely consider careers in science as restricted to research, many students abandon scientific training and undertake other courses. Their ambitions for non-research jobs might well have been satisfied within one of the scientific fields.

Occupational information contained in the following free or inexpensive pamphlets should assist in widening the occupational horizons of qualified students planning a career in science:

1. *Careers in Physics.* American Institute of Physics, 57 East 55th Street, New York 22, New York. (Free.) (No date.)
2. *Careers in Science at the National Bureau of Standards.* Personnel Division, National Bureau of Standards, Washington 25, D. C. (Free.) (No date.)
3. *Factors Affecting Earnings in Chemistry and Chemical Engineering.* U. S. Department of Labor, Bulletin No. 881. For sale by the Superintendent of Documents, Washington 25, D. C. Price 10¢. 1946.
4. *Physical Sciences: Astronomer, Chemist, Geologist, Geophysicist, Mathematician, Meteorologist, Physicist.* National Roster of Scientific and Specialized Personnel. For sale by Supt. of Documents, Washington 25, D. C. Price 10¢. 1947.
5. *The Outlook for Women In Chemistry. (Bulletin 223-2), in Mathematics and Statistics (Bulletin No. 223-4), in Physics and Astronomy (Bulletin No. 223-6).* U. S. Dept. of Labor Women's Bureau. For sale. Price 15¢ each. 1948.
6. *Vocational Guidance in Chemistry and Chemical Engineering.* American Chemical Society, 1155 16th Street, N. W., Washington 6, D. C. (Free.) 1944.

For current occupational information the proper professional organization should be consulted. The publishers of references 1 and 6 in the above list are examples of professional societies. Names and addresses of professional organizations will be found in the *World Almanac.* Professional or trade journals are also useful sources of current occupational information. They may be consulted in the public library. ●

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"One must not follow beaten paths; beaten paths are for beaten men."

—*Ideas, Men and Things*

J. O. PERRINE

Seeing is Believing

(Continued from Page 6)

throw the picture on the screen. The paper film used in the Land-Polaroid camera is of such a texture that it not only permits maximum microscopic magnifications without blurring the picture, but even the use of ultramicroscopic illumination.

These new developments in the field of microscopy and photomicrography certainly deserve far more attention from an educational point of view than they have so far received.

The days when one needed special photomicrographic equipment have passed. The time has come when one can use the same camera for one's daily pleasure and also for photomicrography or for taking close-up pictures of, for example, printed matter, fabrics, and the like. This has been accomplished with two attachments designed for the Leitz Leica camera. The first equipment is the Leitz Micro-Ibso attachment; this uses the microscope eyepiece as its front lens; attached thereto is an optical system which when placed into the Leica casing (after the latter's lens has been removed) will automatically set the focal distance of the film so that it coincides with the correct setting of the microscope. The Micro-Ibso attachment is also equipped with a side viewer which permits one to adjust the preparation as desired without having to remove the camera from the microscope, and even to take pictures while continuing the observation of the preparation under the microscope.

For close-up pictures the ideal attachment is, as stated before, the Leica Focaslide. This piece of equipment consists of two parts, the slider and the base. The lens is unscrewed from the Leica camera and attached to the base, while the camera is secured to the slider through a clamping arrangement. Accurate composing and focusing of the preparation is done on the ground glass of the Focaslide; then the slide is pushed over to place the camera in photographic position and the picture is made. The operation is quick and simple.

In conclusion I would like to draw your attention to one other fairly recent development, namely, the staining of microscopic specimens of crushed minerals and the like without the use of dyes. Although the technique used calls for dark-field illumination, this can easily be secured from any standard-type microscope simply by placing an opaque central stop under a standard 0.28 N.A. condenser and removing the top lens[2]. The technique is based on the so-called Christiansson Effect[3]. If powdered minerals are placed in organic liquids, spectrum colors will be produced from white light by refraction at interfaces of the grain and the liquid. This is the reason why dark-field illumination is essential. Since the minerals under investigation usually differ in their index of refraction, they will show up in different colors[3].

There are of course a few more developments in the field of microscopy and photomicrography, but the ones discussed here seem to be those which are of greatest interest from an educational point of view, particularly at the high school and lower college level. ●

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Electroplating Comes of Age

(Continued from Page 13)

the nickel deposits came out brighter! Thus it was discovered that gums like gum tragacanth, made good addition agents for nickel plating.

With such a background as this, electroplating could expect a slow and tedious uphill climb. It was not until about two decades ago that it began to be realized that electroplating is not an individual art like wood carving, but an engineering process, and that it should be treated accordingly. As a result of this concept developments in electroplating have come rapidly, and the process now is assured a bright future.

Electroplating plants that are built today are scientifically lighted, well ventilated, even air conditioned. Slowly but firmly the old time plater with his trout fisherman high knee boots is being supplanted by the electroplating technician in neat laboratory smock and snappy oxford brogues. Electroplating, long regarded by some as the illegitimate child of electrochemistry and metallurgy has definitely come of age. It's high time we gave it the attention it deserves. ●

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"When we survey the trends that have set in with increasing vigor since the war, we have reason to be deeply concerned for the future of freedom, and with it for the future of the colleges and universities as we know them. If an independent college may be said to be owned by anyone, then we may say it is owned by the future, by freedom. And its function is to make ideas effective and to impart what is requisite for the maintenance and extension of freedom. But in exercising this function we are being resisted today by those who suppose that the cause of freedom can be served by curtailing freedom, by legislating men into intellectual conformity, by intimidation and by exacting a humiliating price for the utterance of unpopular views."

—Otto F. Kraushaar, *Pres., Goucher College*
Ordeal by Freedom
Assn. of American Colleges Bulletin, August '49